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CHEMICAL
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# ENGINEERING

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McGRAW-HILL PUBLISHING COMPANY, INC.

S. D. KIRKPATRICK, Editor

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PROFESSIONAL PUBLICITY—A TWO-EDGED SWORD

TWICE A YEAR, coinciding roughly with the spring and fall meetings of the chemical societies, we have come to expect questions such as these from otherwise intelligent laymen: "Is it true that the chemists are really extracting gold from seawater down in North Carolina?" . . . "Just yesterday I read in the *Tribune* about a German chemist finding 2-cents worth of gold in every ash can. He said New York City throws away $150,000 a year! Is that all 'newspaper chemistry'?" . . . "What about this Chemical Buck Rogers, whose story I read in the *Times,* predicting interplanetary travel, chickens as big as pigs, two-hour days and dream pills? Is there some scientific basis for such wild prophecies?" Perhaps you have had the same experience and already know the answers. Frankly, we've lost patience in trying to explain, for too often the mystified inquirer leaves us with some such remark as this: "Well, you chemists are certainly queer folk. You can't tell what sort of miracles will next come from your test-tubes!"

Such comment might only be amusing, were it not for the fact that it carries the actual threat of serious harm for the chemical profession. It can quickly undo all the good that has been accomplished in the slow process of building up the professional status of the chemist and chemical engineer. As long as the public regards us as "queer," as mystery men or magicians, there is little hope for the recognition and respect that is accorded members of the medical or legal professions. We have a long and difficult road ahead of us in our public relations and it is not made easier by sensational and misleading outgivings in the newspapers.

Who is to blame? Isn't it because the readers of the daily press have so long associated chemistry with mystery and magic that they will not be content to read of the more prosaic but tremendously more important recovery of the bromine from seawater or the perfection of delicate spectroscopic methods that make it possible to determine such minute values as the gold content of ashes? Frankly, we doubt it. During the recent A.C.S. meeting in New York, the *Times* gave even more prominence and space to dignified but interesting and substantial staff articles from the American Physical Society in Washington and the physicians and surgeons meetings in Philadelphia. Surely the largest chemical convention in the world had news value worthy of just as serious consideration.

Perhaps we should not be too critical. We have all been guilty to some extent in this process of "selling" chemistry and chemical engineering to the public. But hasn't the time come now when we should build more substantially and without the fanfare of trumpets or the ballyhoo of sensational publicity? Our most important job is to create in the minds of the intelligent laymen a real understanding of what the chemical profession is and what it stands for. Some of the things we can be thinking more about are the requirements of good citizenship, honest dealings with industry and the public and, last but not least, our own well-being in improving our economic and professional status.

From an EDITORIAL *Viewpoint*

Good Business for Somebody—Soon

BEFORE very much more time has passed there is going to be a lot of business for somebody, if two recent surveys are any indication—and when American business men and industrialists have regained their pre-depression verve. Machinery and Allied Products Institute, MAPI for short, has completed a comprehensive investigation of the dammed-up requirements for machinery and finds that more than 18 billion dollars now needs to be spent in this one field. *American Machinist*, completing its third five-yearly report on the obsolescence of machine tools, states that 65 per cent of this class of equipment is over ten years old and that nearly 600,000 machines will have to be replaced in the next five years to regain the 48 per cent ratio of 1930.

An Obligation About to Fall Due

IN ANOTHER MONTH several hundred young chemical engineers will have completed their college training and will make their bid for a place in our profession. Are we ready for them? There was a time, of course, when the bidding was all on the other side. Some colleges realize that times have changed and are now coming around to the view that their obligation to the student does not end when he has been given a sound engineering schooling. However, there are a number of others, and they include some of the largest and oldest of our universities, that continue to leave the graduate to shift for himself as soon as he has paid his diploma fee. Industry as well as the profession would be better served if the chemical engineering department of every college would recognize and discharge this obligation promptly and effectively.

Re: Our A.C.S. Editorial Staff Report

HOW CAN one editorial staff in three pages report the three hundred years of chemical industry celebrated by 5,105 chemists, engineers and industrialists in New York City, April 22-26, 1935? Not, we hope, by listing the titles of all of the 588 papers, addresses, and discussions that averaged 1.44 authors per paper, address, or discussion. Nor is it necessary to say that the Chemical Industries Tercentenary of the American Chemical Society set a new world's record for chemical conventions. Nor would it be exactly good taste on the part of the hosts to call attention to the $50,000 budget which was contributed largely by American chemical industries and which made possible a somewhat more elaborate scale of entertainment than ever before attempted at a scientific meeting.

So before getting down to such trivial details as the provision of 34 plant trips for 5,000 participants, the chaperoning of 1,000 ladies through the palatial estates of Long Island, a theatre party at Rockefeller Center —or the largest banquet ever held in New York City . . . . well, it's apparent we have run out of superlatives. Maybe we'd better just tell the simple truth for a change. It was a wonderful meeting. All who had a part in it, whether as member, guest, or host, must have carried away the conviction that it was worthwhile for the industry, for the profession and for the individual. And our hats are off to the good chemist, Charles A. Browne, who first dreamed of a historical celebration in honor of John Winthrop, the Younger; to that good chemical engineer, Arthur W. Hixson, who planned and executed the giant project, and to those good chemical patrons, Mr. and Mrs. Francis P. Garvan, whose interest, loyal support and gracious participation helped to make chemical history.

Sensational Publicity Makes Strange Bedfellows for A.C.S.

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Revolutionizing the Refining Of Lubricating Oils

FOR A NUMBER OF YEARS the petroleum industry has provided the largest single market for the services of chemical engineers—employing from an eighth to a fifth of the total graduating classes according to a study made by the American Institute of Chemical Engineers. Likewise, petroleum refining offers one of the largest and fastest growing markets for the products of chemical industry. A recent estimate that the oil industry will spend $100,000,000 this year for chemicals, seems extravagant at first blush yet when one considers the variety of requirements—it is apparent that the industry has changed since the old days when sulphuric acid, caustic soda, and litharge were the refiner's chemical standbys. It is also apparent that such a progressive, process industry offers a most fertile field for chemical engineering achievements and developments.

Most recent and important in the chemical revolution of petroleum refining, is the application of solvent extraction processes in the production of lubricating oils. Within the past year 13 of a total of 21 solvent extraction plants were placed in operation, yielding 17,500 bbl. daily of a total of 23,000 bbl. of finished oil refined by these processes. At least $5,000,000 will be spent in 1935 in the further construction of solvent extraction plants which will bring the total capacity up to perhaps two-thirds of the country's entire consumption of lubricating oils.

Why has this chemical revolution occurred? What does it mean to the public? To chemical industry? The solvent extraction processes hold advantage over the older methods chiefly because of the higher quality of finished oils that can be produced at lower cost and without prohibitive loss of valuable material. By high quality, the oil technologist now means principally high viscosity index, marked resistance to oxidation or sludging, and low carbon-forming tendencies. The solvent extraction processes produce these qualities by selective action on the oil, removing the "naphthenic" portions and leaving behind the "paraffinic" fractions. Sulphuric acid does not show marked selective action of this type although good quality oils can be made provided sufficient quantities are used. Such drastic treatment usually results in greater losses and higher costs.

But it is not safe to say that the new processes will entirely eliminate the acid treating operation. Indications are that total elimination is not economical in all cases and probably not desirable with some stocks even when economical. In conjunction with solvent extraction, sulphuric acid has its place chiefly as a finishing agent to aid the decolorizing action of the clay—a light, acid treatment giving higher yields of oil of desirable color. In each case an economic balance can be worked out for the optimum use of acid, solvent, and clay. Caustic soda, of course, goes hand in hand with sulphuric acid and will probably experience a further decline in its use, although perhaps to a lesser extent.

Before we shed too many tears for these heavy chemicals in their inter-commodity, inter-process battles, it is well to reflect upon the fact that sulphuric acid and caustic soda are both largely used in the production of most of the newer organic chemicals to which the oil industry is now turning. Some of the business lost to petroleum refiners may well be regained from the producers of such chemicals as dichloroethyl ether, phenol, cresylic acid, acetone and nitrobenzol.

Who has been responsible for this advance? To a remarkable extent it has been the result of group effort and achievement by companies rather than by individual chemical engineers. There has been an unusual degree of cooperation between the research and technical staffs of the oil companies on the one hand, and the chemical producers, consulting engineers and equipment manufacturers on the other. Probably the pioneer in the use of organic solvents was the Canadian affiliate of the Standard Oil Co. of N. J., whose phenol extraction plant went into operation in 1930. Liquid SO_2 was, of course, used by the Associated Oil Co. of California as far back as 1924 and more recently by Tidewater, Union, and Shell. The first Chlorex (dichloroethyl ether) extraction plant was installed in 1932 and this process has since risen to an important position under the sponsorship of the Standard Oil Co. of Indiana and the Carbide and Carbon Chemicals Corp. The Atlantic Refining Co. pioneered in the use of nitrobenzol. The Texas Co. developed furfural treating and the use of benzol-acetone mixtures in dewaxing. The Standard of California employs aqueous phenol in its large extraction plant at Richmond. Development of the use of propane for dewaxing and solvent treating has been prosecuted vigorously by the Union Oil Co. of California, Standard Oil Co. of New Jersey and others. The Duo-Sol process using propane and cresylic acid (see *Chem. & Met.*, Feb., 1935, pp. 82-85) was developed by the Max B. Miller Co. in cooperation with Socony-Vacuum and its Magnolia affiliate. The M. W. Kellogg Co., whose manager of research so ably summarizes the status of the whole advance on pp. 246-50 of this issue, has contributed largely to the development of the solvent extraction processes as well as the new propane dewaxing methods that promise a still further and profitable application of chemical engineering technology.

Here indeed is a field where recent chemical engineering achievements have been both frequent and significant. The public has been served by better products. The petroleum industry has been awake to its opportunities to apply new methods, new technology and new equipment in the solution of one of its oldest problems.

A Chemical Engineer's ECONOMIC IMPRESSIONS

By ALBERT E. MARSHALL
President, American Institute of Chemical Engineers, New York, N. Y.

BRITISH ISLES and Continental Europe provide a rather curious contrast these days, Britain living up to its old slogan "Business as usual—during the alterations," whereas Continental Europe is enveloped in an atmosphere of war preparation rumors increasingly fantastic in conception. If, by the chance of things, Continental Europe had been visited first, an impression might have been gained that an armed conflict was just around the corner and a later visit to England, with its pronounced activity in the manifestly peaceful pursuits, particularly the building trades and the rising frameworks of many small factories, would have brought along the question of whether the British people had adopted an ostrich-like policy and refused to recognize the warnings so plainly evident to their Continental neighbors.

Belgium provided a typical example of the current Continental viewpoint in that new projects were being put on the shelf with a shrug and the statement that until the atmosphere cleared there was no point in building a new plant because if anything happened to disturb the peace of Europe, Belgium would once again be used as the arena of conflict. With the order of visits reversed and some time spent in England before going to the Continent, the view is different because the English people have a conviction that war is a rather remote affair and that as new business opportunities are ready to hand, the present is an opportune time for the launching of new ventures.

It was a little difficult to separate optimism from the underlying facts, but as business thrives only when the returns are profitable, the idea suggested itself of checking up happenings of the last several years in the chemical and allied industries through the record of dividends paid by a group of the more important companies that are regularly listed on the London Stock Exchange.

The records of twelve companies engaged in such diverse activities as the manufacture of compressed gases, distillation of tar, manufacture of rayon, plastic moldings, photographic film, petroleum distillation, textile finishing, chemical plant equipment and heavy and fine chemicals were selected. Dividend records over the period 1925 to 1933 with a partial record of 1934 dividends were available and when they were analyzed this tabulation was developed:

1925	12.3%	1929	12 %	1932	9 %
1926	12.3%	1930	9 %	1933	10 %
1927	13.8%	1931	8.3%	1934*	11 %
1928	13.0%	(*Figures available for 7 companies only)			

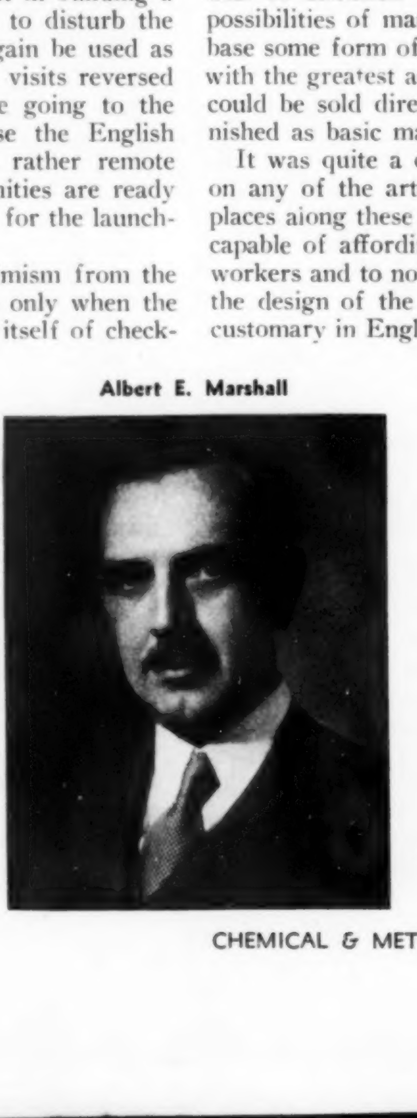
Percentage dividends listed in the above tabulation are based on the par values of the common stocks of the group of companies, and as an indication of returns on current investments, the March average stock exchange prices for the same group showed that an investor purchasing equal amounts of each company's stock would have a dividend income on his investment of 4.3 per cent.

The low point in the period covered by the tabulation was 1931 and it is interesting to compare the 1927 post-War peak in industrial activity in Great Britain, with the low point of 1931 and evident upward trend since 1931.

It was not at all surprising, in view of this excellent showing of the chemical and allied industries, that a great deal of attention was being directed toward the profit possibilities of manufacturing operations having as their base some form of chemical processing of raw materials, with the greatest activity directed toward products which could be sold directly to the consumer rather than furnished as basic materials for some other industry.

It was quite a cheerful sight to drive out of London on any of the arterial highways and to find at various places along these roads little groups of new plants, each capable of affording employment to perhaps 100 to 200 workers and to note the attention which had been paid to the design of the factory buildings. Years ago it was customary in England to house a new venture in a rented factory which might have been built as far back as the early days of Queen Victoria. Today when the process and the product have been proven on a pilot plant scale, the first step toward commercialization seems to lie in acquiring a convenient site and having an architect design suitable buildings.

Albert E. Marshall



That the chemical and allied industries in England are in a healthy state was evidenced by the labor employment figures which showed that for the year 1934 there had been a greater gain in employment in these industries than in all other industries. The general level of employment is higher than it was a year ago, the Board of Trade figures

# of EUROPE in 1935

A view in one of the British plants of Imperial Chemical Industries, Ltd.

issued at the end of March showing that in comparison with March, 1934, there were 139,000 more persons in employment, the total registered unemployed having fallen to 2,153,870.

The active state of the chemical industry in England has led to the planning of a Chemical Engineering Congress at the World Power Conference to be held in London June 22 to 27, 1936. The organizing committee of the Congress has had the project of an International Congress of Chemical Engineering before them for several years and the background of the forthcoming Congress is expressed in rather happy fashion in the foreword to the advance program which has just been issued:

> The decision having been made to hold the Congress, the problem of carrying it into effect was happily solved by the generous and ready co-operation of the International Executive Council of the World Power Conference. Much duplication has thus been avoided, without in any way impairing the autonomy of the Chemical Engineering Congress. The statesmanlike policy of the Council has placed the widespread organization of the World Power Conference at the full disposal of the Congress.
>
> Chemical Engineering has now definitely emerged as a distinct branch of the Engineering profession. This is in no small degree due to the striking developments in the provision of new materials, available both for manufacturing and constructional purposes.
>
> In addition to his connection with the Chemical Industry itself, there is practically no branch of industry in which the Chemical Engineer does not, or might not, contribute valuable assistance. The field of activity of the Chemical Engineer is indeed so wide that close co-operation with other branches of the chemical and engineering professions may be necessary in many problems of major importance, and the realization of this should form part of his education.

The technical program for the Congress includes chemical engineering projects; chemical engineering plant construction; fuel, heat and general problems in chemical engineering and general aspects, under which the in chemical engineering; trend of development in chemical engineering and general aspects under which the committee proposes to group papers dealing with experiences in the translation of semi-scale processes into industrial production; modern developments in pure science and their significance in industry and the functions of national and private research establishments in connection with chemical engineering.

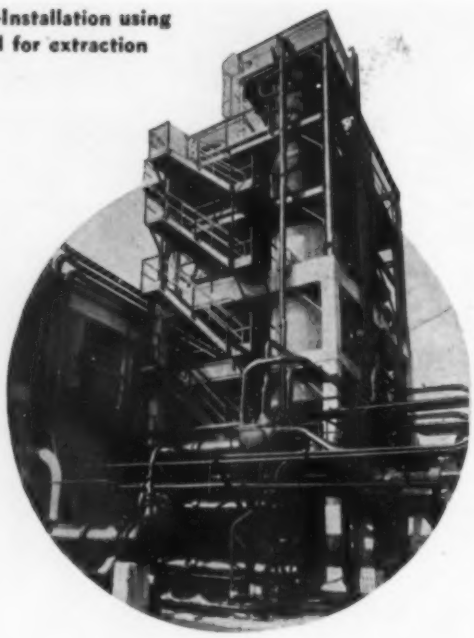
A great deal of preliminary spade work has already been done on the Chemical Engineering Congress and there was every evidence the meeting would be succesful and that it would be attended by chemical engineers from all the important industrial countries.

The American Institute of Chemical Engineers has been invited to attend the Congress and a specific invitation to subsequently participate in a joint meeting with the British Institution of Chemical Engineers has been tendered the Institute.

From the standpoint of the chemical engineer rather than the industrialist, it can be said that interest in European countries is largely being directed toward materials of construction and engineering practice and some interesting new developments are under way which have no exact counterpart in this country. The European chemical industry has always in the past devoted more attention to processes than to equipment for carrying on the processes on a commercial scale. There is now an equal interest in processes and equipment with the result that much less reliance is being placed on low cost of labor as a means of maintaining low production costs. In this connection the employment figures are once more of interest as in many of the works visited, mechanical equipment recently installed must have cut down the number of men for a specific operation so that the overall gain in employment could only be the direct result of improved business.

One thought must occur to everyone who has an opportunity to visit England and look around at its industries, and that is that business in the British Isles has shown an ability to pull itself out of a depression period largely because of the freedom of business to undertake its own measures for recovery. Coupled with this is the further fact that the Government of England has always had, and continues to have, despite trade unionist and socialist members of Parliament, a quite definite belief that the welfare of the people of the British Isles depends almost exclusively on the state of its manufactures, and that encouragement of the manufacturing arts is an essential requirement to good Government.

Fig. 1—Installation using phenol for extraction



Solvent Extraction in PETROLEUM REFINING

By J. T. WARD and H. O. FORREST

Respectively, Director of Research and in Charge of Lubricating Oil Research, M. W. Kellogg Co. New York, N. Y.

SEPARATION of petroleum fractions by means of chemical solvents dates from the earliest researches on the constitution of petroleum and was, at first, largely confined to the fractionation of the light oils. The earliest commercial application was the treatment of kerosene and to a limited extent of lubricating oils with liquid sulphur dioxide. The efficacy of a long list of solvents has been investigated by Ferris, Manley, Cottrell, Stratford, and many others; the field is so broad that the present discussion will be devoted to the features now possessing the greatest commercial significance, i.e., the solvent treating of petroleum fractions for the manufacture of lubricating oils.

During the last few years both motorists and industrial factory operators have become "quality conscious" in respect to the lubricating oils. In the case of the motorist the requirement has been due not only to the demand for higher quality, created partly by competitive efforts on the part of refinery sales organizations, but to changes in automotive engine design resulting in more severe bearing service, greater driving speeds, higher motor temperatures and other mechanical changes and operating requirements which have forced the widespread development of specially processed lubricants.

The commercial importance of the lubricating oil branch of the oil industry is indicated by the facts that in 1934, in the United States alone, the consumption of motor lubricants amounted to at least 10,500,000 bbl., that of industrial lubricating oils to 8,000,000 bbl., a total of 18,500,000 bbl., at an estimated market value of about $120,000,000, manufactured from practically all varieties of crude, and distributed by over 300,000 retailers.

By the refining methods in common use up to recently the quality of the finished oil depended more on the type of crude base used than on the manufacturing process. In "solvent treating," chemicals are employed to separate selectively the desirable from the detrimental components of raw lubricating oil stocks. It is a finishing operation and follows the initial splitting of crude petroleum into its fractions by distillation.

The constituents of unrefined lubricating stocks, whether distillates or residuums, may be classified in several ways, but a most satisfactory grouping has been suggested by the research division of the Union Oil Co., of California (*Natl. Pet. News,* March 6, 1935, pp. 25-31, and private communication). This grouping includes: (1) *Asphaltenes:* dark-colored, high-melting, thermoplastic solids with relatively low ratio of hydrogen to carbon; (2) *Carbogens:* believed to represent, chemically, high-molecular-weight, unsaturated compounds related to the aromatic or coal-tar series, which in service are readily converted to sludge and carbon; (3) *Naphthenes:* cyclic compounds of the polymethylene series, recognized by a comparatively steep viscosity temperature curve and a relatively low flash point for a given viscosity; (4) *Parathenes:* the name given to the highest type of hydrocarbon lubricants, believed to consist largely of naphthenic rings with paraffin side chains in the same molecule; they have been found to combine oiliness, flat viscosity-temperature characteristics, high flash point, stability toward sludge formation, and relatively low carbon-forming tendency; and (5) *Paraffins:* ranging in consistency from soft petrolatums to hard, brittle waxes.

Requirements for Good Lubricating Oil

The more important properties required in high quality lubricating oils have been stated by Wilson and Keith (Proc. 15th Annual meeting, A.P.I., Dallas, Nov., 1934) to be the following: (1) low carbon-forming tendencies; (2) low pour test; (3) high viscosity index (see Dean & Davis, *Chem. & Met.,* Oct., 1929, p. 618); and (4) high resistance to oxidation or sludging. To obtain these properties five types of constituents of ordinary lubricating oil fractions must be eliminated: (1) Wax, to obtain a low pour point; (2) Asphalt, for several reasons, particularly its carbon-forming tendency; (3) Com-

Condensed by the authors from a paper presented at a round-table discussion of solvent refining, held by the North Jersey Section, A.C.S., Elizabeth, N. J., Apr. 8, 1935.

pounds of very high viscosity, intermediate in molecular weight between the asphalts and the heaviest lubricating fractions it is desired to retain, again mainly because of carbon-forming tendencies; (4) Color bodies, primarily to make the oil marketable; and (5) Naphthenic compounds, which are in general responsible for low viscosity indices and low resistance to oxidation.

Among the principal criteria for judging the quality of a lubricating oil are pour test, viscosity index (V.I.), and viscosity gravity constant (V.G.C.).

Compounds for Solvent Extraction

Practically all compounds which might possess selective solvent properties have been investigated, but those solvents for the refining of raw lubricating stocks which are of most commercial value at present may be listed, alphabetically, as follows: acetone, benzol, Chlorex (dichlorethyl ether), dichlor- and trichlorethylene, furfural, nitrobenzol, phenol, propane, propane with phenol, and/or cresols, sulphuric acid and sulphur dioxide, the last either alone or with benzol. Certain others of lesser commercial importance are butane, crotonaldehyde, acrolein, nitrobenzol with sulphuric acid, etc. The refining action of aluminum chloride, caustic soda, and the effect of clay percolation and contacting must also be mentioned, but their effect does not generally proceed by the same mechanism as the series of solvents first listed.

To obtain the properties desired in a lubricating oil it is necessary to remove five types of constituents, but since attention here is directed specifically to removal of non-paraffinic compounds, it must suffice to point out that the asphalts, i.e., the asphaltenes and carbogens, the resinous materials, and the color bodies may be removed separately by distillation, treatment with acid and alkali, or by solvents, propane fractionation, etc.

Removal of wax, to obtain the desired flowing properties at low temperatures, is important, but the complications incident to it are so numerous that any discussion of dewaxing must here be confined to the mere statement that wax may be removed by refrigeration in naphtha solution, followed by centrifuging or pressing and by the use of such solvents as benzol-acetone, propane which possesses unique properties in this respect, and chlorinated solvents such as di- and trichlorethylene, etc.

Even a brief survey of the field of solvent treating should include, first, the physico-chemical principles of solvent treating; second, the types of process to which such methods are adapted; and, third, a discussion of the commercial applicability of the more important processes and of the solvents. The mechanism of solvent treating has been well developed by several writers and with particular clearness and completeness by Hunter and Nash (World Petroleum Congress, July, 1933). The most elemental phase of their treatment may be abstracted as follows:

Assume the presence of a raw lubricating stock as one liquid phase containing two general types of compounds to be separated. A solvent known to be selective for the compounds to be rejected is added. The first increment of solvent will dissolve in both groups of compounds in accordance with normal solubility relationships but with succeeding additions a point will be reached where two phases are formed, one, in which will be concentrated the compounds to be rejected, while the other, containing dissolved solvent, is relatively quite rich in the components desired; the former is called the "extract" and the latter the "raffinate." In this simplest case, which we may assume carried out under isothermal conditions, a common solute is distributed between two immiscible liquid phases. Solute concentrations can then be expressed by the distribution law which takes the form: $C_1/C_2 = K$, where C_1 is the concentration of the solute (non-paraffins) in the first liquid phase; C_2 is the concentration of the solute in the second liquid phase; and K is a constant dependent only on temperature.

When the solute consists of different substances, the law holds for each single material, but where dissociation or association of the solute occurs, certain corrections of the above simple relationship are possible according to known physico-chemical laws. In the solvent treating of lubricating oils the desirable fractions and the solvent cannot be considered as immiscible liquids and the value of K does vary with the amount and characteristics of the material dissolved by the solvent. Hence, the usual concept of distribution ratios in immiscible liquids must be somewhat modified as applied to this extraction process because of the partial miscibility of the two liquid phases.

Commercial Extraction Processes

As in most commercial processes, the efficiency of a solvent extraction system is very largely dependent upon the method of processing. For example, the yield and quality of products from a modern fractionating tower, when used for distilling crude oil, is much greater than that of a series of batch stills. Similarly, the process used for extraction may vary from single batch to true countercurrent operation and the yield and quality of products will change likewise.

In solvent refining the single batch method requires

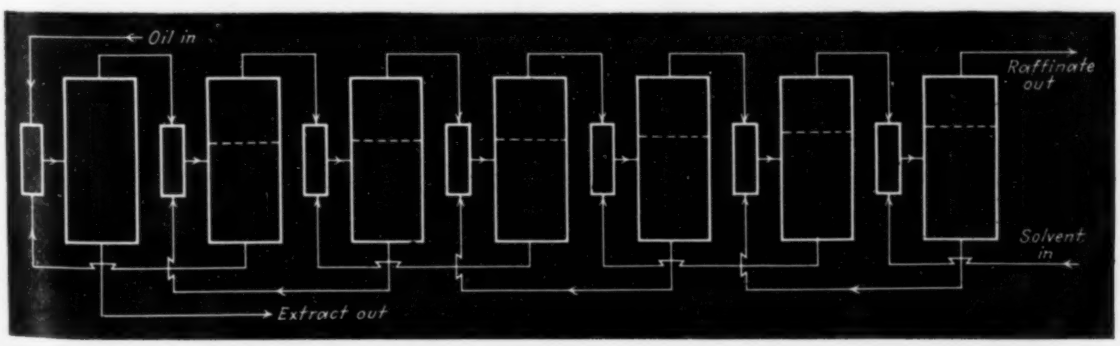


Fig. 2—Seven-stage, counter-current, solvent-treating system

an excessive quantity of solvent and will produce low yields of oil of the required quality; this method has little commercial significance. Use of a number of simple batch extractions in series and so proportioning the quantities of solvent in each step that a minimum is used, decreases considerably the amount of solvent required, but, because of the partial miscibility of the two phases, still results in a relatively low yield. Several investigators, using different solvents, have shown that the solvent requirements may be as much as 200 per cent of that necessary in a fully countercurrent system and the yield as much as 10 to 20 per cent lower.

The most efficient method is obviously the countercurrent system, using either a series of mixers and settlers, mixers and centrifugal separators, or a packed column. A commercial installation of this type of system, treating distillate oils with phenol and using centrifugal separation of extract and raffinate, appears in Fig. 1. In Fig. 2 a countercurrent system with settling tanks is shown diagrammatically.

The most compact system is the packed column, giving the most truly countercurrent operation. The simplest type of tower treater is shown by the *full* lines in Fig. 3. The solvent flows downward, countercurrent to the ascending stream of oil. The raffinate is withdrawn from a small disengaging space at the top and the extract from a similar chamber at the bottom. The packing usually consists of sections of Raschig rings separated by some means for redistributing the two phases over the cross section and a tower equivalent to at least eight stages can be of practical height.

Although the countercurrent tower may be considered analogous to the bubble, the method of operation as presented in the full lines of Fig. 3 omits one of the vital factors of control, that is, reflux.

Just as a rectifying tower depends on reflux for most efficient operation and for prevention of loss of valuable products in the overhead, so does maximum yield from a solvent treating process also depend upon refluxing. In this case, the reflux should be solvent-free extract. The most naphthenic oils are most soluble in the solvents and the oils of intermediate paraffinicity may be rejected to the feed for further processing by refluxing the bottom of the column with solvent-free extract. This is shown by the dotted lines in Fig. 3. In an operation of this type the characteristics of the extract system are determined by the amount of reflux used.

Other methods of obtaining such reflux may be used. For example, (1) the character of the solvent may be changed by decreasing the temperature or adding a modifying component (*e.g.*, water to phenol); or (2) the distribution may be changed by adding a third component to the system which will form an upper layer of more paraffinic components (*e.g.*, use of propane for washing extract).

To obtain maximum yield of desired products it is imperative that the solvent be not permitted to leave the system in equilibrium with the feed, but rather in equilibrium with a more naphthenic material, and this equilibrium may be changed by recycling of extract or by changing the character of the solvent or of the upper phase with which it is last in contact.

The effect of modifying the solvent after it has been in equilibrium with the fresh feed is strikingly shown by the tabulation in Fig. 4 of results of batch experiments in which water was added to a phenol extract from a Mid-Continent distillate. The data shown are undoubtedly not representative of the best conditions, but do show here that by proper modification of the solvent (i.e., refluxing), the initial yield of 57.1 per cent of raffinate was raised to 75.5 per cent with no sacrifice in quality.

The various methods of processing outlined above are

Table I—Distribution of Processes Among U. S. Solvent-Treating Plants

Solvent	Charging Capacity Bbl. per Day
SO_2 or SO_2-Benzol	12,992
Nitrobenzol	2,350
Chlorex	4,715
Propane-Cresol-Phenol	7,530
Furfural	1,500
Nitrobenzol + Acid	1,000
Phenol	13,280

Fig. 3—Packed column for countercurrent extraction

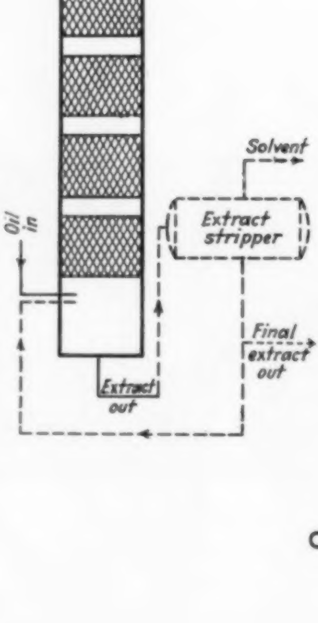
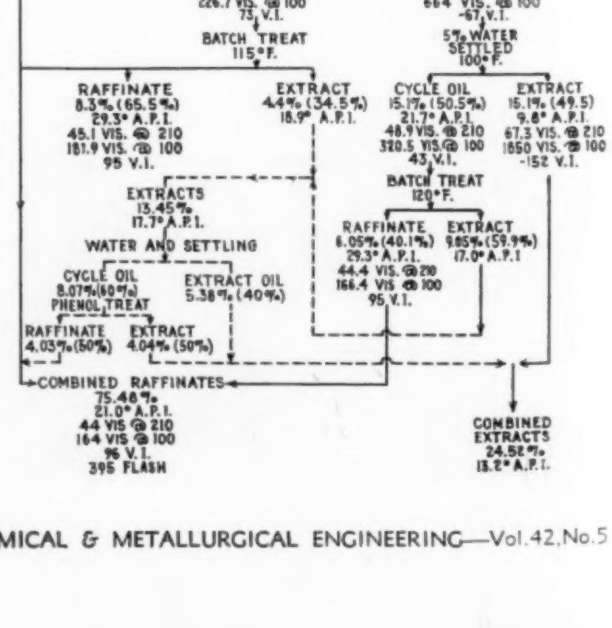
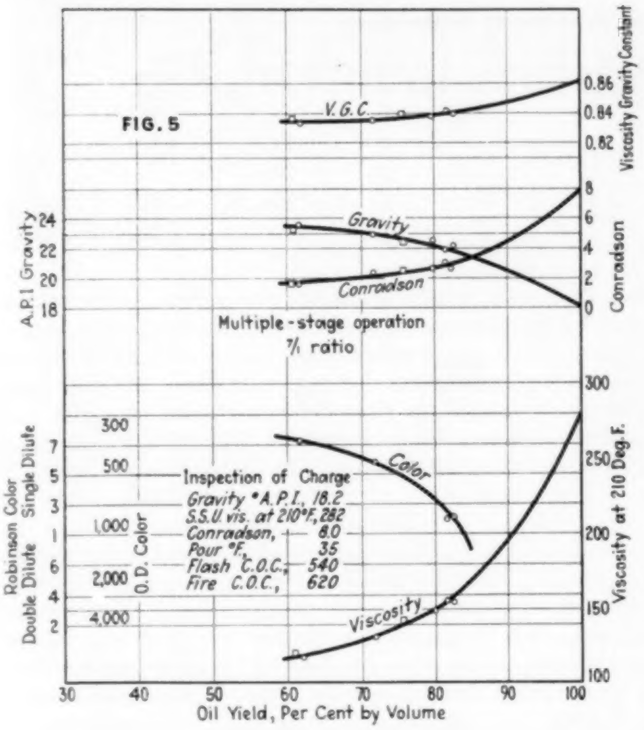
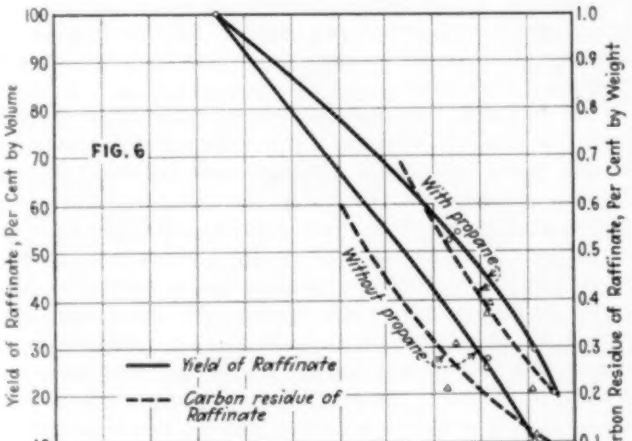


Fig. 4—Effect of modifying phenol solvent with water in batch extraction of Mid-Continent crude







Figs. 5 and 6—Respectively, effect of propane deasphalting and desinating of Mid-Continent red crude; and effect of propane in nitrobenzol extraction of deasphaltized, dewaxed Kettleman Hills long residuum

applicable to any of the many solvents listed. In general, it may be stated that the differences in degree of separation obtainable with the individual solvents are often the lesser in comparison with the differences in method of operation, despite differences in the solubility and selectivity of the various solvents. There is some indication that the selectivity of some of the solvents is not satisfactory in the range of greatest paraffinicity, and that the solution capacity of others becomes relatively low in this same range. As different specifications for the finished oils are required in specific cases, varying operating conditions are required and an equality among these solvents as to commercial value does not exist and each case must be evaluated on its own merits as to final cost.

Among the more important commercial processes available to the refiner are those using: (1) sulphur dioxide and its modification with benzol; (2) Chlorex (dichlorethyl ether); (3) furfural; (4) phenol; (5) nitrobenzol, and (6) propane, alone or with other solvents, such as cresols and phenol, or with sulphuric acid.

In a recent survey, Ziegenhein (*Oil & Gas J.*, March 28, 1935) estimated that the charging capacity of 28 commercial solvent-treating plants, either in operation or building, as of January, 1935, was 43,000 bbl. per day, of which 34,000 bbl. was in the United States. This capacity is divided among the several solvents as shown in Table I.

It is believed that the SO_2 plants installed before 1930 were primarily for the treatment of light oils, but proved to be adaptable to some raw lube stocks. Probably the first large commercial solvent-treating plant for the production of first-quality lubricants was the installation at the Imperial Oil Co., Ltd., refinery at Sarnia, Ont., where phenol was the solvent employed. In addition to the plants in the table, it is understood that The Texas Co. is preparing to install a 4,500-bbl. furfural plant. The solvents enumerated are all being used in the production of marketable lubricating oils depending on specific conditions, i.e., SO_2 and SO_2-benzol on California and Gulf Coast oils; Chlorex on Pennsylvania or most highly paraffinic oils, and phenol and furfural on intermediate stocks, for the most part. All of the widely used single-solvent processes are employed on clean stocks, either a distillate or a clean residuum such as a Pennsylvania long residuum, because, with the possible exception of nitrobenzol, they do not seem to be particularly well adapted to the removal of color bodies and carbogens.

The two-solvent process, i.e., propane with other solvents, is used primarily for the treatment of residual stocks, and to remove not only the naphthenes but also the asphalts, carbogens, and color bodies. In removing four of the five principal classes of compounds in a raw lubricating stock the principal task of the solvent is the separation of the essentially paraffinic or parathenic from the non-paraffinic constituents. However, a solvent which would do this and also eliminate the other objectionable materials would possess greatly increased value. Such a solvent is propane which is the cheapest solvent available, is non-toxic, non-corrosive, extremely stable and can be used to advantage both as a diluent and as a refrigerant for the complete removal of wax. At present, propane is being used effectively for the separation not only of wax but of asphalt, heavy ends, color bodies and "naphthenic compounds." It owes its versatility as a solvent to the fact that its properties change very rapidly between —44 and +215 deg. F.; in which range it possesses the properties of a series of solvents.

As Wilson and Keith stated before the American Petroleum Institute (*vide supra*), "Between +70 and —44 deg. F. the main uses of propane are in connection with dewaxing and are due to (1) its extremely low viscosity, (2) its property of self-refrigeration and (3) its very low solvent power for wax at low temperatures. At temperatures above 70 deg. F. propane finds its use as a preferential precipitant. For example, it has been demonstrated that in the restrictive range of 100 to 140 deg. F., asphalt is only slightly soluble in propane, whereas at these same temperatures both oil and wax dissolve completely. In the temperature interval of 100 to 212 deg. F. and under its vapor pressure the surprising and novel property of propane is that, instead of behav-

Table II—Propane Fractionation of Pennsylvania Bright Stock

	Gravity, Deg. A.P.I.	Flash Point, Deg. F.	Visc. at 100 Deg. F. (Secs.)	Visc. at 210 Deg. F. (Secs.)	Visc. Index	Pour Point, Deg. F.	Color T. R.	Con-radson Carbon	Per Cent on Charge
Original	26.6	550	2337	150.9	100	25	¾	1.69	100.00
Cuts 1 and 2	....	...	....	.....	...	..	..	....	3.68
Cut 3	25.3	560	4023	218.4	102	25	[illegible]	2.48	10.24
Cut 4	25.4	565	3543	199.8	102	25	[illegible]	2.47	12.84
Cut 5	25.6	560	3495	197.4	101	25	[illegible]	2.51	9.52
Cuts 6 and 7	25.7	570	3093	180.6	100	25	[illegible]	2.31	8.05
Cut 8	26.6	545	2076	138.8	99	25	1[illegible]	1.55	12.30
Cuts 9 and 10	26.8	550	2082	139.3	99	25	1[illegible]	1.45	6.37
Balance in solution	27.5	535	1485	112.6	97	30	1[illegible]	1.19	37.00

ing like an ordinary liquid and dissolving more of any partially soluble substance as the temperature is raised, it actually dissolves less. In general, we find that heavier compounds are rejected first but as the physical properties of propane become increasingly those of a gas it dissolves less and less oil until finally no viscous oil remains in solution at 212.2 deg. F., the critical temperature of propane."

The system, propane-oil-asphalt, can be represented to great advantage as a three-component system, as shown by Wilson and Keith. Here it is probably sufficient to illustrate first the results of propane as a solvent in deasphalting and deresinating, second, propane as a solvent permitting fractionation of dissolved compounds as a function of temperature, and, third, propane as an aid to other solvents. The first of these is shown in Fig. 5, where the results of deasphalting and deresinating an 18.2-deg. A.P.I. Mid-Continent reduced crude are given in graphical form.

The ability of propane to fractionate a series of cuts of progressively changing properties from a base stock is shown in Table II, which gives the effects produced when Pennsylvania bright stock was dissolved in propane. As the temperature was successively raised in definite intervals the lower phase thus produced was withdrawn in such a manner that this stock was separated into ten distinct fractions.

The third outstanding feature of propane listed above was its properties when used with other solvents, such as cresols and phenol. This is demonstrated in the Duo-Sol Process (Max. B. Miller Co.) and in those processes developed under the Jersey, Union, Indiana, and Kellogg patents and licensed by M. W. Kellogg Co.

Propane Improves Yield and Quality

It has been found that the solution pressure of the naphthenic and high molecular-weight compounds is raised in the presence of propane and that, furthermore, this increase in solution pressure can be increased either by the addition of more propane or by a rise in temperature. Therefore, propane should aid materially in removing these fractions by solvent extraction. This effect was demonstrated by extracting a deasphalted Kettleman Hills residuum with nitrobenzine, with and without propane, with the results shown in Fig. 6. The effect of propane is marked not only in increasing the yield, but in improving the quality of the raffinate.

The same is observed in sulphuric acid treating; the action of sulphuric acid is primarily that of a solvent, preferentially dissolving asphaltic and color bodies, and, since propane under certain conditions preferentially tends to precipitate these compounds, the action of acid with propane is much more effective than the action of acid alone. There are, of course, other contributing factors, among which is the dilution effect. One refiner in the manufacture of a Mid-Continent quality bright stock, when using propane has found it possible to reduce the acid requirements by approximately 80 per cent. The procedure is to first deasphalt with propane and then to acid treat in propane solution. In this instance acid is saved in three ways: (1) Asphalt is precipitated, which, in the absence of propane, was usually dissolved with the acid. (2) The percentage bottoms to which the raw stock is reduced is decreased, since with the use of propane no diluent gas oil is needed. Finally, (3) because of the preferentially precipitating action of the propane, the distribution ratio between the acid sludge and the remaining oil is so changed that the acid becomes a much better solvent for the color bodies. Moreover, acid treating in propane solution makes it impossible to treat at too high a temperature. Any tendency of the acid to generate heat is compensated by vaporization of propane which tends to keep the whole body of oil at a constant temperature.

The primary purpose for which these solvents are generally used is removal of the non-parathenic compounds with consequent improvement in temperature-viscosity relationship (or V.I.), but the results as given above indicate that they may also be used for removal of part or all of the other detrimental substances, except the wax. For example, when the heavy asphaltic residuum, containing all of the undesirable materials, was treated by the two-solvent process, i.e., propane with cresols and phenol, the quality of the oil was improved to such an extent in color and Conradson carbon, as well as in V.I., by selective solution, that no further refining step was necessary, except dewaxing and possibly a slight color improvement.

There has been included in this summary no discussion of the relative cost of treating by these methods compared to those employed formerly. In general, these are not sufficiently different to have caused any major upset in lubricating oil costs and in many cases a differential in the cost is in favor of the solvent process. On this point reference should be made to papers by Wilson and Keith (A.P.I. meeting, Pittsburgh, July, 1934), Ferris, Myers and Peterkin (*Ind. Eng. Chem.*, **23**, 1931, 753), and others in the proceedings of the American Petroleum Institute for 1933 and 1934.

The supply of the solvents mentioned seems to be ample for any reasonable usage now apparent.

Solvent refining of petroleum fractions has grown to be a major refinery operation. A tremendous amount of research leading to the perfection of solvent processes has been prosecuted with great speed and efficiency. It has proved to be a workable and effective means toward raising the quality of lubricants abruptly to a very high level to meet drastically changed conditions and requirements.

Chemical Industries Tercentenary

EDITORIAL STAFF REPORT

Editor's Note: From John Winthrop, Jr., whom President Roger Adams of the American Chemical Society referred to as "chemical practitioner to sick Indians and Colonial Governors," down to Father Julius A. Nieuwland of Notre Dame, chemistry's most recent and modest medallist, is an indication of the broad span of activities and interests covered by the Tercentenary meeting in New York City, April 22-27. We could not hope to touch on more than a few of the high-spots in these pages and rather than skim the surface of it all, we propose to confine our attention here to brief resumes of the general meeting and the symposia on chemical economics and chemistry's contribution to the construction industry.

BEFORE what was probably the largest chemical audience over assembled, five men—an organic chemist, a chemical engineer, a technically trained executive, the lawyer-president of another large chemical corporation, and a chemical prophet and past-master of showmanship—provided a unique demonstration of the catholicity of interest and influence represented by chemical industries.

President Roger Adams, head of the Department of Chemistry of the University of Illinois, made a strong plea for a better comprehension on the part of the public of the true significance of chemical development, of chemical research and of the chemist himself. He pictured him, not as the test-tube magician, but as a "hard-working, cultured professional man who is an asset to any community."

The chemical engineer, Professor Alfred H. White of the University of Michigan, spoke of the scientific foundation of American chemical industries. "Our brains are not superior to those of Aristotle, Sir Francis Bacon or Benjamin Franklin," he said. "The only reason we are making more rapid progress than they did is that we have access to a background of previously prepared knowledge, to books and journals where are stored not only data about countless individual materials and reactions, but also the complete plans of many building units which are helpful in constructing the scientific foundation of a new process. . . . After all the necessary data have been assembled, the process and equipment may now be designed with the same precision as is the building which is to house the units."

Lammot duPont, president of E. I. duPont de Nemours & Co., chose to discuss "Human Wants and Chemical Industries." Of our basic needs he listed six—food, shelter, clothing, medication, transportation and amusement—to all of which chemistry has made important contributions, largely as the result of research. He scored the modern feature writers who love to concoct lurid accounts of chemical accomplishments, and cater to the popular notion that research is a sort of black magic, carried on by pallid individuals who work amidst a weird maze of apparatus, brew vile-smelling liquids and gases and pull chemical discoveries out of test tubes like rabbits out of a hat. "Research, the foundation of nearly all progress in chemical industry, is today a business-like pursuit, conducted along clearly defined lines with definite objectives in view. Its chief purposes are to improve existing processes and products and if possible to develop new ones."

Typical of the newer products now emerging from research is a new type of rayon for cord fabrics that will double or triple the life of heavy-duty automobile and truck tires. New insecticides in which organic chemicals replace lead and arsenic are other examples of better meeting human needs.

Mr. duPont closed his address with a strong appeal for all chemists, engineers and industrialists to join in a sound program of national recovery in which private initiative could have the opportunity to supply more of human needs and thereby create more jobs.

William B. Bell, chairman of the American Cyanamid and Chemical Corp., carried the enthusiastic interest of the large audience with him in an astute and witty attack on the New Deal. His subject "Recovery by Alchemy or Chemistry" gave him an excellent opportunity to compare the panaceas and cure-alls of the ancients with some of the futilities of governmental planning. As a capable and brilliant attorney, he reviewed and completely refuted the Administration's indictment against the private planning of business. He quoted Brookings Institute to show that with the exception of the railroads, the coal and oil industries, there is really no over-capacity in American industry—certainly less than in government today. Speaking of reform, Mr. Bell said that the one most needed is honest enforcement of present laws—not more new ones. Citing Colonel Ayres' figures on the backlog of business in the durable goods industries alone, he concluded that "this country is ready for recovery and nothing but continued, incomprehensible foolishness on the part of government can keep us away from prosperity."

Thomas Midgley, chairman of the board of the American Chemical Society and vice president of the Ethyl Gasoline Corp., concluded the session with an astounding forecast of "Chemistry in the Next Century." Hampered only by the fact that a 1935 imagination is incapable of comprehending all of the scientific possibilities of 2035, the able showman nevertheless presented a startling assortment of events and developments classified as "probabilities which do not overstep the boundaries of accepted natural laws." Many other discoveries, he predicted, will result in radical revisions of the natural laws of today.

Here are a few of the things this Chemical Buck Rogers envisions: "Interplanetary travel, control of the age cycle, elimination of adolescence, disappearance of disease, a perennially bountiful agriculture, a maximum two-hour day, bulls the size of mastadons, chickens as big as pigs and laying eggs the size of footballs (all by the application of synthetic hormones to produce growth), indigestion pills from the stomachs of boa-constrictors, and, finally, certain selective dream tablets (with which we strongly suspect our good friend has been experimenting).

Chemistry of the Dollar

Popular and financial interest in the chemical industry was recognized in the organization of a symposium on chemical economics. The first symposium in this undeveloped and little explored field was held at the society's autumn meeting in 1929, but since then there has been only the pain and silence of the depression.

The present symposium was organized under the direction of Dr. Roland P. Soule, chemical economist for Tri-Continental Corp., who was also chairman of the meeting. In his introduction Dr. Soule emphasized the fact that the chemical industry is made up of no closely-knit group of companies. There is no common product as in the steel industry; no common market as in the case of automobiles. The only common link is the rather tenuous bond of common chemical processes. Moreover, not even the largest of the chemical companies covers all branches of the industry, and could thus be taken as a typical cross-section of the industry. Obviously under these circumstances a symposium on chemical economics could deal with only a few problems of the industry.

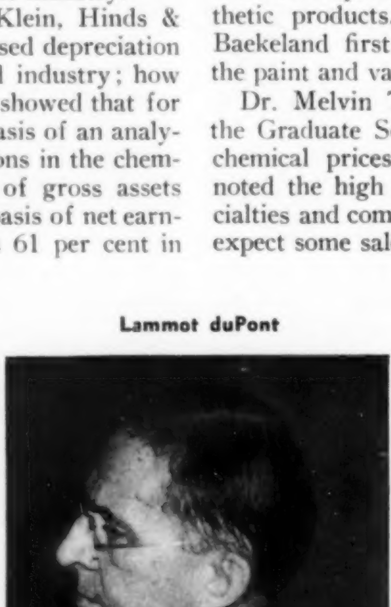
Dr. Joseph J. Klein of the firm of Klein, Hinds & Finke, certified public accountants, discussed depreciation and obsolescence charges in the chemical industry; how affected by the "New Deal." Dr. Klein showed that for the six years from 1929 to 1934, on the basis of an analysis of the reports of 20 leading corporations in the chemical industry the depreciation in terms of gross assets varied from 4.2 to 4.9 per cent. On the basis of net earnings, however, the ratio was as high as 61 per cent in 1934, and in terms of dividends was never lower than about 66 per cent during the six years. Until the most recent revenue act, according to Dr. Klein, Congress always favored a reasonable allowance for exhaustion, wear and tear of business property, including obsolescence. But in the 1934 Act, in its effort to restrict tax deductions resulting from security net losses to $2,000, Congress unnecessarily extended the limitation to factory equipment with the ridiculous result that frequently it is advisable for management to abandon its property or have it actually destroyed rather than to sell it for scrap value. While the Treasury Department opposed the proposal to gain additional revenues by limiting depreciation deductions to 75 per cent of actual depreciation, taxpayers now do have the burden of supporting their depreciation claims. Dr. Klein feels that too much is at stake in the form of surtaxes and excess profit tax penalties for the chemical industry to acquiesce readily in arbitrary changes in depreciation policy, especially since the industry suffers especially from such factors as chemical corrosion and thermal breakage, as well as such occurrences as the introduction of synthetic indigo and the production of rayon. He concluded by showing that early replacement of equipment makes for reduced prices to consumers, increased demand for capital goods, increased employment, and so forth.

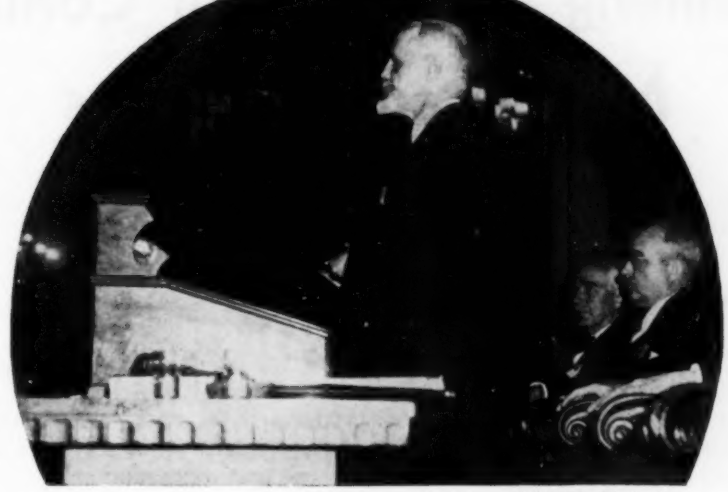
Frank Howard's paper on autarchy in 1935 was delivered by Robert Russell, vice-president of the Standard Oil Development Co. He contrasted the present widespread idea of prohibitive tariffs and national self-sufficiency with the 19th century (or even pre-depression) idea of free trade. Autarchy might be defined as the theory that holds that all commodities consumed within a country should normally and naturally be produced at home without regard to the additional cost which this lays upon the consumer. Exceptions would be granted only when necessary for valid reasons. Howard believes that there is less reason for autarchy to become a popular issue in America than in Europe, but notes that its effects abroad result in a downward trend in our exports, and an unnatural stimulation of chemical synthesis. Of course the fundamental roots of autarchy are monetary difficulties and unemployment, although military independence is also a factor. The issue today is no longer free trade vs. protection, but protection vs. autarchy.

Dr. Leo H. Baekeland, grand old man of American chemistry, gave a most interesting account of the industrial development of Bakelite, that pioneer among synthetic products. It is now over 25 years since Dr. Baekeland first prepared it, yet recent applications in the paint and varnish industries are revolutionary.

Dr. Melvin T. Copeland, professor of marketing in the Graduate School of Business at Harvard, discussed chemical prices: their recent and future trends. He noted the high cost of marketing certain chemical specialties and commented that "it is not more reasonable to expect some sales manager to hit upon the most effective and economical method of marketing, without careful analysis and controlled experimentation, than it is to expect a production manager to hit upon the best chemical process to be used in a given instance." In discussing the recent trend of chemical prices Dr. Copeland showed the divergent tendencies of various products: "at one extreme we find sulphuric acid, muriatic acid, nitric acid, indigo, and sulphur black, where there has been practically no change in prices during the last six or eight years." "Sodium nitrate, methanol and butyl acetate, at the other extreme, have fallen 40 to 50 per cent within the last ten years." Dr. Copeland concludes that his study has indicated the probability that chemical prices will not

Lammot duPont





Wide World photos

William B. Bell, Alfred H. White and Thomas Midgley, Jr., along with Lammot duPont were the speakers at the chemical industries symposium

advance as rapidly during the next ten years as the general commodity index rises, but they cannot dodge entirely the influences of currency devaluation (already accomplished) which "at the present time seem certain to cause the cost of living at least to double during the next ten years or thereabouts, possibly much sooner."

Chemistry's Influence on the Building Industry

The products of chemical research which are expected to bring revolutionary improvements in building construction were described at the symposium on materials of construction in the building industry, over which Prof. Jas. R. Withrow, of Ohio State University, presided. Papers were presented by representatives of the building, chemical, steel, electrical, rubber, ceramics, gas machines and other industries.

The use of stainless steels and special steels in prefabricated buildings was cited as one development which is destined to exercise a permanent and far-reaching influence. The extended use of stainless steel products on building exteriors is one of the most significant of present-day trends. The use of exteriors of steel products permits much thinner walls, which in turn creates more effective floor space. In large buildings this alone is worthy of careful consideration.

As roofing material, Monel metal and stainless steel have shown their economic value in long life with low maintenance cost. The most prominent buildings on which stainless steel has been utilized as a roofing material, and for miscellaneous sheet metal work, are the Empire State Building and the Chrysler Building.

One of the most important, present-day uses of architectural aluminum has been in the manufacture of spandrels. Inserted between the bottom of each window and top of the one below it in a building, they enhance its artistic impression by relieving the flatness of the masonry. Since the color may be made to either blend with that of the windows, when seen at a distance, or form a contrast, many pleasing effects may be obtained. A wide variety of surfaces may be produced on architectural aluminum in order to achieve desired color effects. It may be etched, sandblasted, scratched, brushed, buffed or polished; and accordingly any color from black through to gray into bright metal may be produced.

A new type of lead is now available possessing all the characteristics of ordinary lead and having some new valuable properties in addition. Tellurium produces a marked change in the physical structure of lead, which results in a lead of greater resistance to corrosion by acid, greater tensile strength, greater resistance to fatigue failure, resulting from vibration of some repeated stresses, and also has better working qualities.

Another step forward is the production of synthetic resins, from which whole sections of houses can be built. Today, there is a large selection of molded hardware available, including the conventional mortise type latch sets, pulls and cupboard turns. Molded hardware is stocked in three colors, dull black, glossy black and walnut.

The introduction of synthetic oil-soluble resins to the paint and varnish industry represents a definite step forward in the quality and durability of finishes of all kinds. Most of the leading paint and varnish manufacturers are using these resins today, as an ingredient in their various formulas.

Some of the most outstanding recent advances in finishes for construction painting have been in connection with metal protection. Both the glyceryl phthalate and the phenolic type film-forming materials are characterized by high water impermeability and excellent retention of film integrity on exposure. Both of these properties are of vital importance in metal finishes.

Determining Efficiency of Continuous Mixers and Reactors

By R. B. MacMULLIN and M. WEBER, JR.
Research Laboratory
Mathieson Alkali Works, Inc.
Niagara Falls, N. Y.

WITH THE ADOPTION of large scale methods by the chemical industry, there has been a tendency to use continuous operations wherever possible in place of the older batch methods. Continuity has its advantages in reduced labor costs and more uniform output, but the fact that it may result in a decreased capacity per unit volume of apparatus has not been generally recognized. Recent studies in connection with the design of apparatus for handling reacting materials in continuous flow necessitated an exact method of predicting the amount of short-circuiting of materials passing through either single mixing tanks or a number of them in series.

Ham and Coe (*Chem. & Met.*, **19**, 1918, p. 663) have worked out the general case for extraction in a series of tanks. They appreciate the importance of short-circuiting and suggest means of predicting apparatus volume required to accomplish certain tasks. The present article is an attempt to fill in the gaps in what has already been done, and to present a complete treatment applicable to any problem in this field.

The problem of short-circuiting in continuous-flow systems becomes acute whenever there is a departure from streamline motion. Many operations, such as chemical reactions, aging and rectification, require vigorous agitation as the *sine qua non* of efficiency. It is not easy to streamline a common mixing tank. It is customary, therefore, to improve the streamline quality by dividing the system into a number of mixing tanks in series.

The present work is limited to a consideration of such a series of tanks, in each of which there is adequate mixing. By adequate mixing we mean that a random sample from any part of the tank will not differ appreciably in composition from the average for the whole tank. Even in tanks equipped with ordinary paddle agitators, such a condition generally obtains.

Effects of Short-Circuiting

Original Tank Contents—In a series of n tanks of equal volume, V, filled with a solution or uniform suspension, the fraction of the original contents remaining after time, t, during which a rate of flow, F, is maintained, is

$$Z_n = e^{-x}\left(1 + \frac{n-1}{n}\cdot\frac{x}{\underline{|1}} + \frac{n-2}{n}\cdot\frac{x^2}{\underline{|2}} + \dots + \frac{2}{n}\cdot\frac{x^{n-2}}{\underline{|n-2}} + \frac{1}{n}\cdot\frac{x^{n-1}}{\underline{|n-1}}\right) \quad (1)$$

where x = the ratio of the time, t, to the nominal holding time for one tank, or $x = Ft/V$. When n is large, then for values of x/n less than unity, the above equation reduces to $Z_n = 1 - x/n$, which simply means that we have changed from a system of washing out by dilution to one approximating actual displacement of the original contents by the washing liquid. The relation between Z and x/n for various numbers of tanks in series is given in Fig. 1.

Incoming Flow—In a series of tanks of equal volume, through which fluid is flowing continuously, the fraction of the throughput, y, which remains in the system for time, t, or longer is

$$y_n = e^{-x}\left(1 + \frac{x}{\underline{|1}} + \frac{x^2}{\underline{|2}} + \frac{x^3}{\underline{|3}} + \dots + \frac{x^{n-2}}{\underline{|n-2}} + \frac{x^{n-1}}{\underline{|n-1}}\right) \quad (2)$$

If values of y_n are plotted against x/n for various values of n (Fig. 2), we obtain a family of curves showing the effect of subdividing the system into any number of stages while holding the total volume constant.

Continuous Reactors

If we are interested in bringing a certain reaction, involving either a physical or a chemical change, to a predetermined stage of completion, then account must be taken of the kinetics of the reaction under the special conditions of continuous operation.

Case 1, First-Order Reactions—For reactions which proceed according to the velocity equation $dc/dt = -kc$, in a batch system, the degree of completeness of reaction in a continuous system is

$$D = 1 - \frac{1}{(1 + k\theta)^n} \quad (3)$$

Since θ represents the nominal holding time for a single tank, $n\theta$ is the nominal holding time for the system; this product remains constant for all systems of equal volume and equal throughput, regardless of the number of tanks. However, since the value of k also affects the kinetic capacity of the system, comparisons can be made only on the basis of the group, $nk\theta$, which we may designate as ϕ_1 and refer as the "Modulus of Reaction Flow, First Order." The solid curves of Fig. 3 show the relations between D and ϕ_1 for various values of n.

For the purpose of comparing batch and continuous

Condensed from a paper presented by the authors under the title of "The Theory of Short-Circuiting in Continuous-Flow Mixing Vessels in Series," before the Wilmington meeting of the American Institute of Chemical Engineers, May, 1935. The original paper contains complete mathematical derivations, together with tabulations of all data used for plotting charts.

systems, we have designated the term "Volumetric Efficiency," defined as the ratio of the volume of a batch system achieving a certain rate of output at a certain decomposition, to the volume of a continuous system of tanks in series achieving the same rate of output and decomposition. It may be defined alternatively as the ratio of the output of a continuous system to that of a batch system of equal volume, when compared at equal decomposition. For first-order reactions, the volumetric efficiency is

$$E = \frac{kt}{nk\theta} = \frac{\ln (1-D)^{-\frac{1}{n}}}{(1-D)^{-\frac{1}{n}} - 1}$$

The dotted curves of Fig. 3 show this relationship between volumetric efficiency and the completeness of first-order reactions for various numbers of continuous reactors in series.

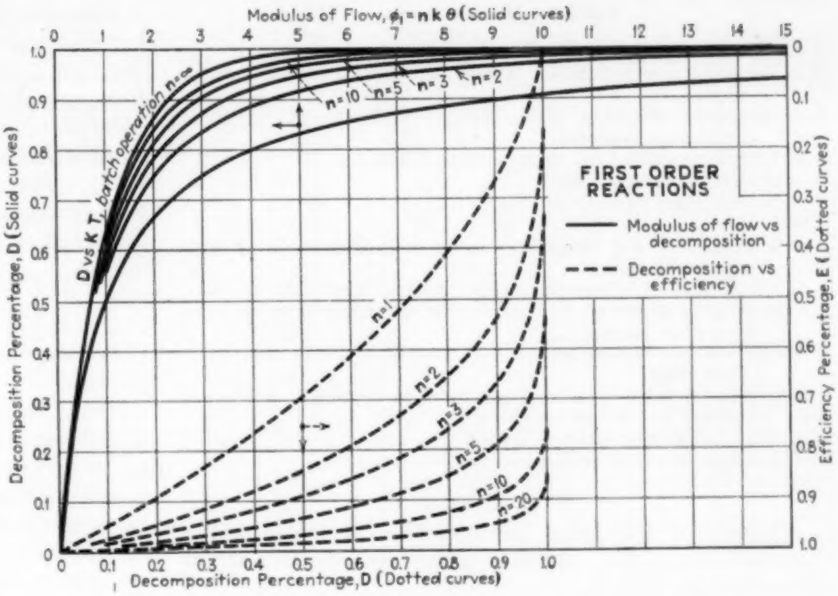


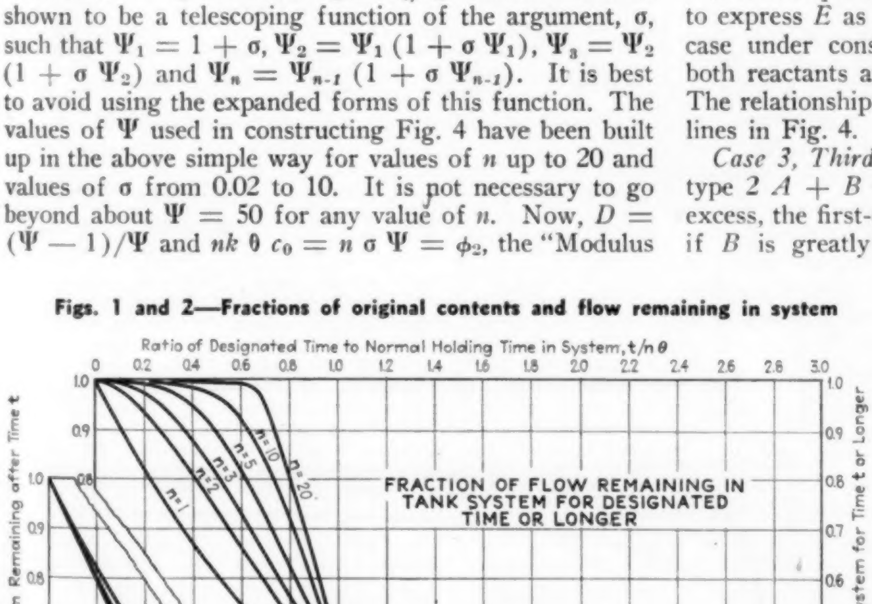
Fig. 3—Decomposition and efficiency, first order reactions

Case 2, Second-Order Reactions—Where one of the reacting substances is greatly in excess, the reaction conforms, for all practical purposes, to the equations for the first order. When the two reacting substances are present in equivalent concentrations, the following relations hold: Let $k\ \theta\ c_n = \sigma$ and $\Psi_n = c_0/c_n$. Then Ψ can be shown to be a telescoping function of the argument, σ, such that $\Psi_1 = 1 + \sigma$, $\Psi_2 = \Psi_1 (1 + \sigma \Psi_1)$, $\Psi_3 = \Psi_2 (1 + \sigma \Psi_2)$ and $\Psi_n = \Psi_{n-1} (1 + \sigma \Psi_{n-1})$. It is best to avoid using the expanded forms of this function. The values of Ψ used in constructing Fig. 4 have been built up in the above simple way for values of n up to 20 and values of σ from 0.02 to 10. It is not necessary to go beyond about $\Psi = 50$ for any value of n. Now, $D = (\Psi - 1)/\Psi$ and $nk\ \theta\ c_0 = n\ \sigma\ \Psi = \phi_2$, the "Modulus of Reaction-Flow, Second Order." In Fig. 4 we have plotted D against ϕ_2 in the solid curves. As n is increased to infinity, the curves approach the batch reaction curve, which integrates into the form: $D_{\text{batch}} = k\ t\ c_0/(1 + k\ t\ c_0)$.

It is not practical, for reactions above the first order, to express E as a direct function of D. For the special case under consideration, where the concentrations of both reactants are equal, $E = D/n\ \sigma = (\Psi - 1)/\phi_2$. The relationship between D and E is shown as the dotted lines in Fig. 4.

Case 3, Third-Order Reactions—In a reaction of the type $2\ A + B \rightarrow$ reaction products, if A is greatly in excess, the first-order equations will apply satisfactorily; if B is greatly in excess, the second-order equations apply.

Figs. 1 and 2—Fractions of original contents and flow remaining in system



For the case where A and B are present in equivalent concentrations, designating the group $k\ \theta c_n^2$ as σ, Ψ is a telescoping function such that $\Psi_n = \Psi_{n-1}\ (1 + \sigma\ \Psi_{n-1}^2)$. Then $D = (\Psi - 1)/\Psi$ and $\phi_3 = n\ k\ \theta\ c_0^2 = n\sigma\ {}_3\Psi^2$. In Fig. 5 values of D have been plotted against ϕ_3 as the solid lines. The curve for $n = \infty$ is obtained by integrating the batch equation to:

$$D_{\text{batch}} = 1 - 1/\sqrt{1 + 2\ k\ t\ c_0^2}.$$

For the special case where initial concentrations are equivalent,

$$E = (\Psi^2 - 1)/2\ n\ \sigma\ \Psi^2$$
$$= (\Psi^2 - 1)/2\phi_3.$$

Case 4, Rates of Solution—(*a*) The case where the quantity of solid is very large and the area of the interface is, therefore, constant can be treated as a first-order reaction. It must be remembered, however, in applying the equations and curves, that D is defined

Table I—Nomenclature

c = concentration per unit volume.
D = decomposition percentage (ratio actual to theoretical maximum).
E = volumetric efficiency (ratio volumes of batch and equivalent continuous systems).
k = specific reaction rate, same units as c and t.
n = number of tanks in series.
r = kinetic order of reaction.
t = time.
u = a measure of any property varying with time and approaching equilibrium.
$x = t/\theta$ = ratio of actual to nominal holding time for one tank.
y = fraction of incoming flow remaining in tank system for total time t, or longer.
Z = fraction of original contents of system of tanks remaining after time t.
θ = nominal holding time in single tank, in consistent units.
σ = "argument" of ψ function.
$\psi = c_o/c_n$ = function defined in text.
ϕ = modulus of reaction-flow.

as the ratio of the actual concentration of solute to the maximum obtainable, which is in this case the saturation concentration.

(*b*) For the case where just enough solid is added to form a saturated solution, the kinetics are those of a 5/3 order reaction, whence $\sigma = k\,\theta\,c^{2/3}$ and $\Psi_n = \Psi_{n-1}(1 + \sigma\,\Psi_{n-1}^{2/3})$. The "Modulus of Solution-Flow" is $\phi_{5/3} = n\,k\,\theta\,c^{2/3} = n\,\sigma\,\Psi^{2/3}$ and the volumetric efficiency is $E = \dfrac{3\,(\Psi^{2/3} - 1)}{2\,n\,\sigma\,\Psi^{2/3}} = \dfrac{3\,(\Psi^{2/3} - 1)}{2\,\phi_{5/3}}$

Case 5, Heterogeneous Reactions—Where the solubility of the solid phase is small, the solid phase is finely divided, and agitation is adequate, the solution may be considered substantially saturated with that component at all times. The solubility of the solid phase may, of course, be altered by the changing concentrations of other components, but where this does not occur to any appreciable extent the order of the reaction is reduced by one unit. When this does occur, thereby giving an indefinite and variable reaction order, the problem is best handled graphically, as in Case 7. The volumetric efficiency is to be worked out for each individual problem.

Case 6, Chemical Reactions of rth Order (Summary)—From Table II the various functions and equations can be set up for reactions of any order and systems of any number of tanks.

Case 7, Miscellaneous Reactions (Graphical Method)—Continuous mixing tanks may be used for a variety of purposes, which may or may not involve changes which conform to one of the equations for homogeneous reactions. But in any case, there is some measure of the change being effected.

If we perform a batch experiment in apparatus similar to that to be used in continuous flow, we can plot the measure of change, u, against time, as in the left-hand sketch of Fig. 6. We have then to combine this information with the holding time curves of Fig. 2 in order to calculate the degree of change that will result when the material is flowing through a continuous system of n tanks in series.

Consider the total flow to be made up of a large number of equal streams, each of which remains in the system for a different time, varying from zero to infinity. For each stream, or value of y, there is a definite value of $t/n\theta$. Since $n\,\theta$ is defined by the apparatus and flow assumed and t is known for each particular stream, $u = f\,(t)$. Plot y against u as in the right-hand sketch of Fig. 6, and integrate to find U, the average property in the overflow of the nth tank. That is:

$$U_{av} = \int u\,dy$$

This integration may be performed with a planimeter, a mechanical integraph, or by Simpson's Rule. For the last y should be divided in at least 20 parts of 0.05 each. In order that the integral may be determinate, it is advisable so to arrange the function, u, that it approaches unity at infinite time. It is also advisable to carry out the batch experiment until u has for all practical purposes reached its equilibrium value, u_∞.

To determine the volumetric efficiency, plot the calculated values of u_n, as determined graphically, against $n\,\theta$, and compare t and $n\,\theta$ at equal values of u. Then $E = t/n\,\theta$.

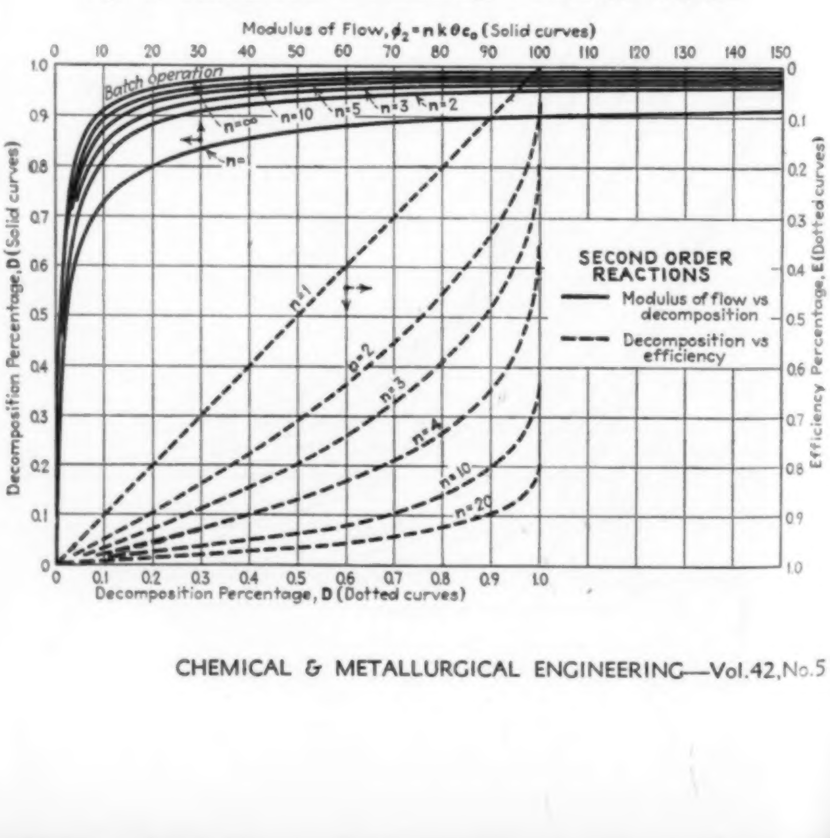
Applications

Problem 1—Determination of Reaction Constant—Given a system of n tanks in series, all of equal volume, and the reacting materials fed in continuously at one end and discharged from the other at a constant rate, it is only necessary to analyze the dis-

Table II—Functions and equations for reactions of any order

Symbol	Order of reaction	Number of stages	Equation
k_r	r	–	$\dfrac{dc}{dt} = -kc^r$
σ_r	r	–	$\sigma_r = k_r\,\theta c^{r-1}$
${}_r\psi_n$	r	n	${}_r\psi_n = {}_r\psi_{n-1}\left(1 + \sigma_r \cdot {}_r\psi_{n-1}^{r-1}\right)$
ϕ_r	r	n	$\phi_r = nk_r\,\theta c_o^{r-1} = n\,\sigma_r \cdot {}_r\psi_n^{r-1}$
D_r	r	–	$D_r = \dfrac{{}_r\psi - 1}{{}_r\psi}$
E_r	r	n	$E_r = \dfrac{{}_r\psi_n^{r-1} - 1}{(r-1)\,\phi_r}$

Fig. 4—Decomposition and efficiency, second-order reactions



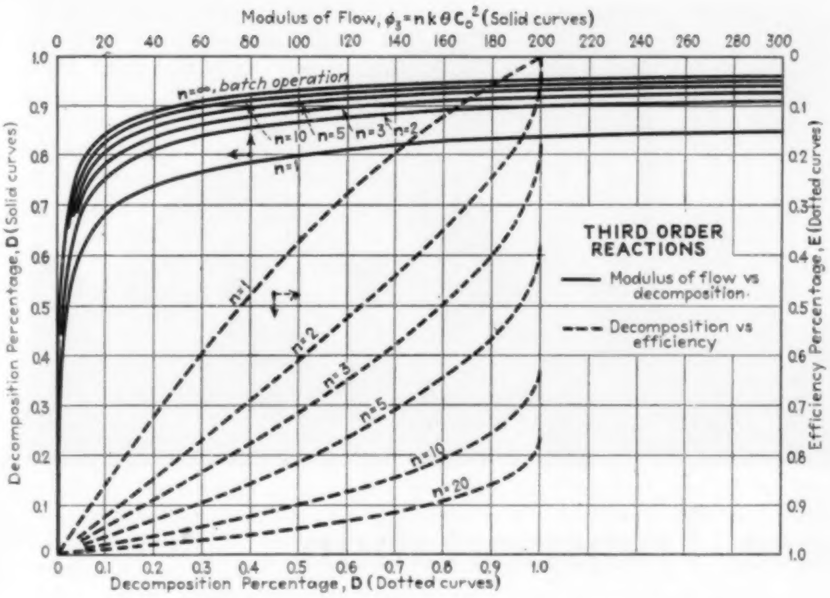


Fig. 5—Decomposition and efficiency, third-order reactions

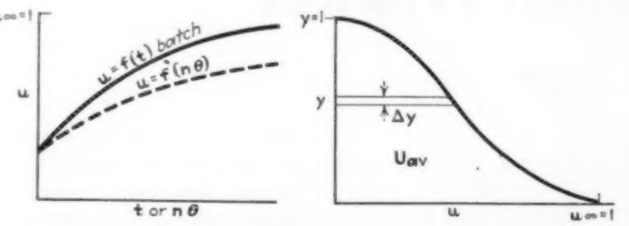


Fig. 6—Graphical solution for miscellaneous reactions

charge for decomposition in order to calculate the reaction constant. If the order of the reaction is known, look up on the proper D vs. ϕ diagrams the value of ϕ for n tanks. Then $k_r = \phi_r / n\theta c_0^{r-1}$.

To check the assumed order of the reaction, vary the holding time, θ, by changing either the flow or the number of tanks. After waiting for the steady state to obtain, measure D again.

The constancy of k_r is the criterion of the proper choice of reaction order, r. This reaction order is true only if the reactants are chemically equivalent. If one or more is greatly in excess, r will be fictitious, but nevertheless of practical value in design.

Example—There are two vessels of 100 gal. each in cascade. The initial concentration of the component analyzed is 3 mols per liter. When flowing at 100 gal. per hour a decomposition of 90 per cent is obtained; and at 200 gal. per hour, only 84.3 per cent. What is the order of reaction and the velocity constant? Here $c_0 = 3$ mols per liter, $V = 100$ gal. and $n = 2$. Then, tabulating values:

			—First Order—		—Second Order—	
F	θ	D	$nk\theta$	k	$nk\theta c_0$	k
100	1.00	0.900	4.35	2.175	26.50	4.425
200	0.50	0.843	3.06	3.060	13.25	4.425

We find that the reaction is evidently second order and $k = 4.425$.

Problem 2—Given the performance of a batch system, what decomposition will be obtained when the system is changed over to continuous operation at the same rate of output?

(*A*) Suppose the reaction to be first order, like the hydrolysis of sucrose, and that a 95 per cent decomposition is normally obtained from a batch reactor in the standard time of 10 hours.

Reading off the D values from Fig. 3 we get:

Number of Stages	D	$nk\theta$	Number of Stages	D	$nk\theta$
Batch	0.950	....	3	0.875	3.0
1	0.750	3.0	5	0.905	3.0
2	0.839	3.0	10	0.925	3.0

(*B*) If now we allow 2 hours idleness in the batch system, for filling, discharging, washing, etc., the effective time is 12 hours, $nk\theta = 3.6$ and the comparison will be as follows:

Number of Stages	D	$nk\theta$
Batch	0.950	....
1	0.782	3.6
2	0.871	3.6
3	0.907	3.6
5	0.935	3.6
10	0.951	3.6

In this case the decomposition will not suffer if the system contains at least ten tanks.

Problem 3—Given a single batch tank giving 95 per cent decomposition for a second order reaction, it is desired to make the process continuous by adding more tanks, of equal size and operating in series. How many additional tanks are required?

Referring to Fig. 4, we find that at $D = 0.95$, ϕ for batch $= 19.0$, and for various numbers of tanks, as follows.

n	ϕ	D	n	ϕ	D
1	19	0.792	3	57	0.957
2	38	0.919	5	95	0.978

It is obvious that two additional tanks are required to maintain the 95 per cent decomposition. This allows for no lost time in batch operation.

Problem 4—What combination of size and number of tanks to accomplish a given task in continuous operation is most economical as to first cost?

Assume we are dealing with a first-order reaction that is to be carried to 95 per cent completion. Also assume that the cost of a single batch tank be taken as a standard cost, and that the cost of a tank of any other size will vary as the ⅔ power of the volume. This is only an approximate relationship; where cost data are available, actual quotations should be used.

We look up on Fig. 3 the volumetric efficiencies at 95 per cent decomposition, and then calculate the individual sizes of tanks as follows:

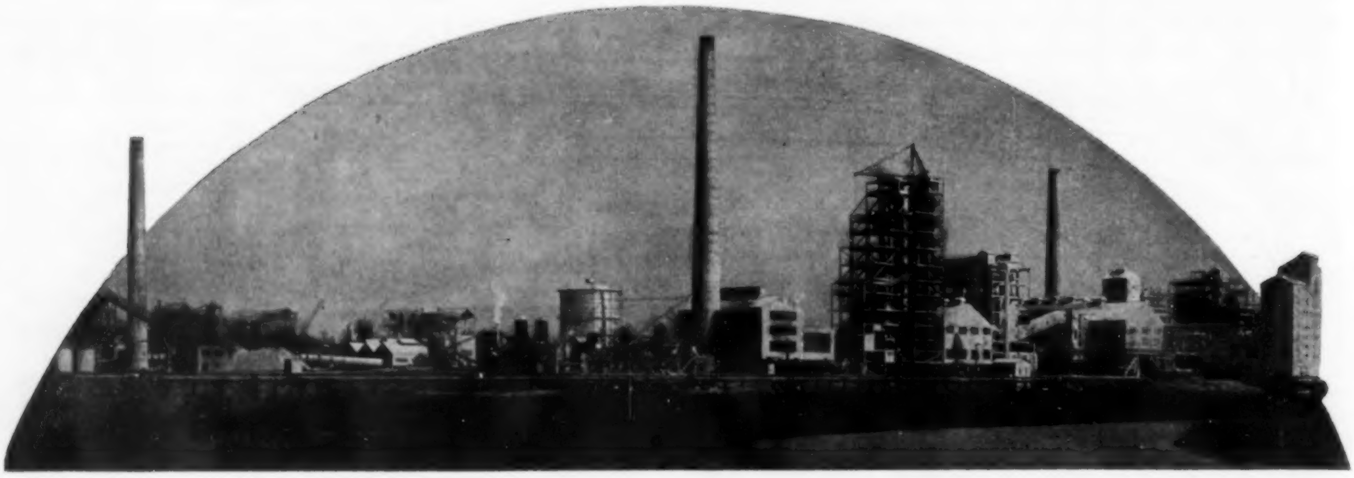
	——Relatives——			Unit Cost	Total Cost
n	E	nV	V	$V^{2/3}$	$nV^{2/3}$
1	0.159	6.30	6.30	3.410	3.410
2	0.430	2.33	1.17	1.110	2.220
3	0.583	1.71	0.57	0.690	2.070
5	0.730	1.37	0.28	0.428	2.140
10	0.857	1.17	0.117	0.240	2.400
20	0.926	1.08	0.054	0.143	2.860
Batch	1.000	1.00	1.000	1.000	1.000

We find that under such conditions the most economical combination for continuous operation is three tanks, each 0.57 times as large as the batch tank.

Problem 5—How much time must be allowed to purge a system from any specified amount of impurity?

Suppose we have five tanks of 2,000 bbl. each, operating as continuous-flow treating tanks in series. Assume it is desired to purge 99 per cent of the present contents of the tank system with fresh oil flowing at the rate of 5 bbl. per minute.

Referring to Fig. 1, we find for $n = 5$ and $Z = 0.01$, that $t/n\ \theta = 1.9$. Since $\theta = 2{,}000/5 = 400$, then $t = 1.9 \times 5 \times 400 = 3{,}800$ min. required to accomplish the required degree of purging. Some 19,000 bbl. of oil would be required. If the tanks had been pumped empty to purge the system only 10,000 bbl. would have been pumped out. However, another 10,000 bbl. would have to be pumped in again, so actually, in the matter of oil pumped and time required, the continuous purge figures out to advantage.



Adequate Transportation Increases Potential Market

EDITORIAL STAFF

SELECTION of an optimum site for an industrial project brings several important factors up for consideration. The plant should be located where the total cost of raw materials, transportation of these materials to the plant, operating, selling, and shipment of the finished products to the market will be a minimum. Failure to consider all of these important points in choosing a plant location has undoubtedly been responsible for the failure of many promising enterprises and has retarded the development of others.

Suitable transportation may increase the permissible shipping distances for both raw materials and finished products, thus enlarging the potential market and increasing the profits of the company. In selecting a suitable location for its southwestern plant Mathieson Alkali Works chose a site at Lake Charles, La., where many unusual transportation facilities are afforded, and these facilities have been supplemented with equally fine loading and shipping accommodations.

The plant is near the outskirts of the city, on a tract of land large enough to permit increasing the present plant capacity several times and, also, to provide for customer industries consuming the plant products. The buildings have been arranged to take advantage of a straight-line flow of materials and provisions have been made for the construction of additional units to any or all of the various steps in the processes, if required.

Several interesting features in the construction of the buildings may be noted. They are actually fireproof as neither wood nor any other combustible material has been used in their construction. Due to the high winds common in the Gulf Coast region it was necessary to make the buildings sufficiently strong to withstand 180 mile winds. The sides of several of the processing buildings were left open. This was possible because of the mild weather the year round in this locality.

The plant is in the center of an elliptical shaped spur, three-quarters of a mile in length, from the main lines of the Southern Pacific and Kansas City Southern railways which pass along the eastern boundary of the Mathieson property. Along the western side of the plant the spur is triple-tracked to provide loading facilities for the different types of products. Running parallel to the buildings and the triple trackage is a 3,000 ft. slip that was dredged in from the Calcasieu River. This slip is 120 ft. wide at the bottom and 32 ft. deep, thus allowing coastwise vessels to dock at the company's wharf.

The shipping building, erected on the edge of the slip and over two of the tracks, is situated opposite the finish end of the soda ash plant. The ash is conveyed high above the tracks in a 12-in. pipe line by a screw conveyor in which the hot ash, on its way from the process building to the shipping building, is being cooled by the continuous churning of the screw. The cooled ash is stored in bins at the top of the building, from which it is screened and fed into box cars or into the bag filling equipment.

One track serves for shipment of bulk material, the other handles the packaged product. The three parallel tracks were laid on a 0.7 ft. grade to permit easy shifting of cars. When a railroad box car is loaded with bulk material it is shifted into the building and placed on the track scale, the doors on both ends of the building are closed and a slight vacuum is applied to prevent the escape of soda ash into the outside air. The loading is done with a pneumatic Manierre loader.

For loading packages the box car is moved into the building on the other track; here the packages come down a chute from the packaging floor above to the door of the car. The bag packaging machine sews bags and tapes them shut so there is no sifting of the ash from the bag. One hundred pound packages are loaded at a rate of ½ ton per min.

Barges and steamers can also be handled from this building. Packages are loaded with the aid of a chute on the water side of the building. The 50 per cent caustic soda solution is loaded into vessels from this building at the rate of 100 tons (solid equivalent) per hour; the barges that bring the crude oil to the plant are used for this material. The solution is conveyed to the shipping building in a cast iron pipe line.

The third track, the one nearest the process buildings, is used for loading liquid caustic into tank cars. The cars are first thoroughly washed and steamed, and then filled with a pipe line near the end of the caustic building.

Oyster shells from Calcasieu Lake, coal and coke, the raw materials used in the production of lime, are received on barges at a wharf, several hundred yards from the shipping wharf. These materials are unloaded by a crane and dropped onto a belt conveyor which carries them to piles near the loading end of the lime kilns. This belt conveyor passes through a rotary washer where the mud is removed from the shells by river water. When unloading coal or coke the washer is bypassed. The reclaimer loads shells, coal and coke onto another belt conveyor which delivers them to bins above the kilns.

Not only is the plant well equipped for unloading raw materials and loading finished products, but it is unusually favorably situated for shipping the products to the consuming markets. The main lines of both the Southern Pacific and the Kansas City Southern Railway pass the front door of the plant, and the Missouri Pacific comes to Lake Charles and can be used for shipping out of town at no extra charge for switching. These rail facilities place the plant only 44 hr. from Kansas City, 40 hr. from Tulsa and Oklahoma City, 38 hr. from St. Louis and 11 hr. from New Orleans.

The plant is also advantageously situated for shipment by water. It is on the Calcasieu River, which gives a deep-water connection to the Intracoastal Canal, ten miles distant. This canal extends from New Orleans to Texas points and is a valuable interior water route to deep sea ports. By means of the 30-ft. channel through the river and Calcasieu Lake the coastwise ships can reach the Gulf of Mexico.

In order to speed delivery of soda ash and caustic to the eastern market the Mathieson company has purchased storage facilities in the New York and Boston harbors. The alkalis will be shipped from the Lake Charles plant to these storage points in coastwise vessels and reshipped from these points on demand.

New plant of Mathieson Alkali Works at Lake Charles, La. In lower view may be seen the unusually fine transportation facilities. Two railroads are just beyond plant. On extreme right is entrance to slip from Calcasieu River. Packaging and shipping building is in center on edge of slip

Protecting Pressure Vessels With Rupture Disks

By M. E. BONYUN
Engineering Department, Dye Works
E. I. duPont de Nemours & Co.
Deepwater Point, N. J.

IN DISCUSSING the development of the frangible disk as a protective device for unfired pressure vessels a short historic sketch will serve to lead up to the present state of the art. Possibly the most comprehensive study of this subject of rupture disks that we were able to find before launching into experimental work for our own instruction was the work done by the U. S. Bureau of Standards, in Washington, during 1920 and 1921. The experimental work, as indicated in the report of the Bureau, was undertaken as a result of numerous requests for advice on safety disks of the type used on gas cylinders. These containers are of small volume and intended for high pressure, with small relief openings, so the Bureau's investigations were limited to disks of $\frac{3}{4}$-in. diameter, with relief openings of from $\frac{1}{16}$ to $\frac{3}{8}$ in. Although they experimented with several metals, even gold and platinum, their efforts were largely confined to cold-rolled copper.

The scope of the Bureau's work did not take into consideration the effect of the gas in the container on the material of the disk, to our mind a most important feature. Their experimental work did, however, consider the effect of temperatures, even those as low as the temperature of liquid air, although they submitted no dissertation or concurrent data concerning the rupture point at various temperatures. Their report stated that, at the temperature of liquid air, the rupture pressure was increased by a factor of about 2, so that it might be said that their findings were concerned with physical conditions only.

Mechanically, the feature of most importance to the writer in the work of the Bureau is the influence of the holder and the character of the relief openings on the breaking points of the disk. Experiments were made, using holders having openings with sharp edges and also with edges slightly rounded. It was found that where a sharp edge of the holder was presented to the disk, a shearing rupture occurred; whereas, in the case of the rounded edge opening, the break occurred at the crest of the bulge, but that in all cases the break, or rupture, produced by shear, as in the first instance, was more uniform than those ruptures produced by tension occurring at the crest of the bulge. This, in a measure, has checked our experience; but, had the Bureau's research extended to disks used at low pressures and, consequently, of large diameter, they would have found the tendency to shear, rather than to rupture, was greater in the case of the smaller diameter disks, even though the edges of the larger openings were sharp.

At the time of these original studies by the Bureau of Standards, there had been little or nothing published on this subject and engineering handbooks were absolutely devoid of anything pertaining to the "rupturing of diaphragms." Hence, the situation as we faced it in 1923, in order to establish the rupture disk as the most adequate protective device for pressure vessels, called for a considerable amount of original research and was undoubtedly of triple consideration: mechanical, chemical and thermal. We began our work pressed by an urgent demand for a device of merit, since by several sad experiences it had been proven that the relief valve in common use was not to be relied upon as an instrument of protection against excess gas pressure, backed by liquid and solid matter carried in suspension. Also, such so-called "safety disks" as were then in use were cut from the commonest kind of scrap metal, which would often include even roofing tin inserted between flanges, and with little or no knowledge of its breaking point.

Experiments With Rupture Disks

After reviewing the situation that existed up to this time, we decided to carry along certain experiments with the view of attempting to establish what merit, if any, there might be in using selected metals of different types and thicknesses. We therefore accumulated sheets of brass, copper, tin, sheet iron, german silver, Everdur, Monel metal and aluminum, hardly believing that any of these could be put to serious use, but feeling that by experimenting with them, they would point the way to the right quality and the proper thickness. Since these samples were but commercially rolled sheet metals, even adjacent sections of the same sheets varied appreciably in thickness, and it was evident from the very start that we must have metal rolled to exact thickness, to be physically reliable. At first, the copper mills turned our orders down flatly when we specified sheets rolled with practically no tolerance.

Meanwhile, the chemists were advising us to adopt nickel as the most reliable disk material. We could not at first obtain sheet nickel as a commercial article anywhere. Finally, by dint of persuasion, we were able to obtain copper rolled in strips of 6 in. width, 0.005, 0.006 and 0.007 in. thick. Also, by persistent effort, the nickel mills agreed to roll pure nickel strips 4 in. wide and 0.008 in. thick, but they refused our order for thinner

Condensed from a paper presented by the author under the title of "Frangible Disks as Protection for Pressure Vessels" before the Wilmington meeting of the American Institute of Chemical Engineers, May, 1935.

material. Eventually, without relinquishing our demand, we finally obtained nickel 0.004 in., and even 0.003 in. thick. We had no great difficulty in obtaining aluminum rolled to exact specifications, nor any at all in obtaining silver as thin as 0.002 in.

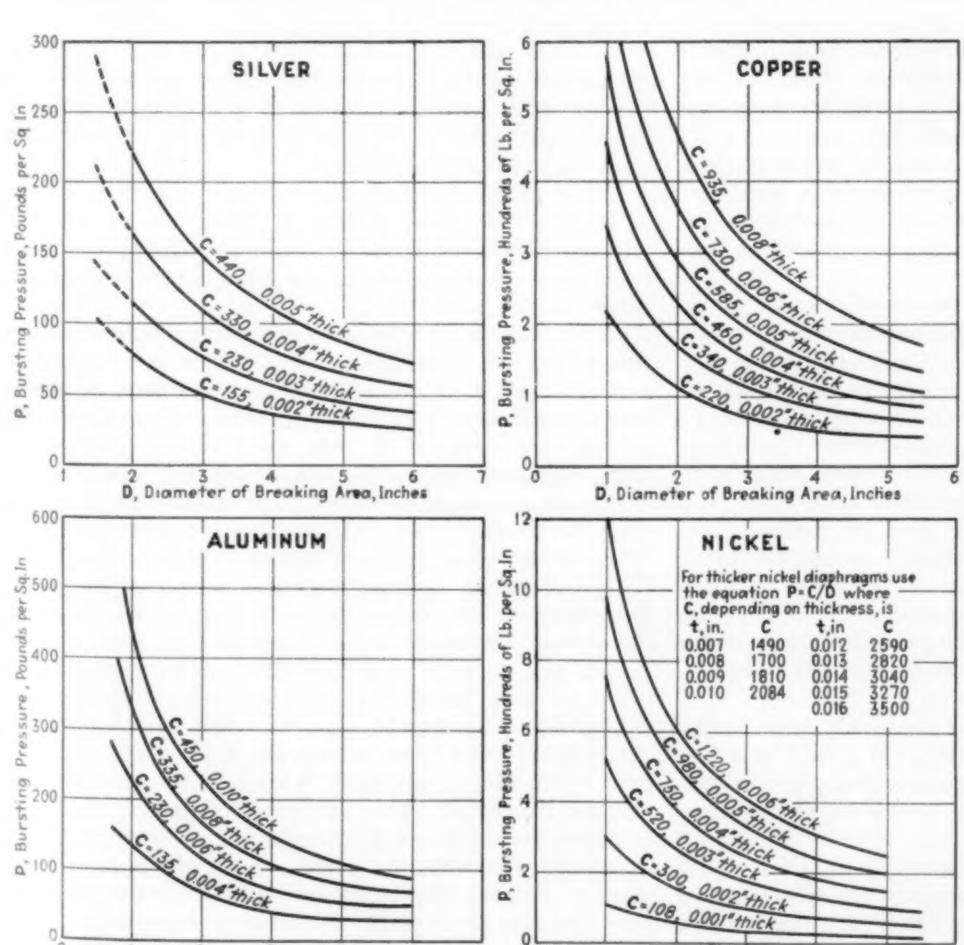
The point of rupture of these various metals at different thicknesses was ascertained by numerous trials at a fixed diameter and, again, by varying the diameter and maintaining the thickness constant. These tests required many months of experimental work; the results in the meanwhile were being put into practice, but were subject from day to day to radical changes, as our knowledge advanced. Finally, out of the mass of data accumulated in this way, we selected that portion pertaining to the use of 100 per cent fine silver, 99 per cent pure nickel, electrolytic copper and aluminum, all annealed, as in a limited way meeting our immediate requirements, both chemically and physically. By this process, we had eliminated commercial tinned sheet iron, brass, bronze, german silver and also Monel metal, since it was quickly determined that the physical characteristics of alloy metals were erratic when rolled to the desired thinness, in that at constant thickness and fixed diameter, the results varied greatly. Again, alloyed metals introduced chemical complications which were insuperable. Our experience seemed to indicate that none but pure metals would survive as frangible disk material for the protection of pressure vessels.

The data accumulated from the tests of these several metals were tabulated and expressed in graphic form. In plotting the curves which characterized the rupture points (of which Figs. 1-5 are typical), we used, as abscissas, the diameters of breaking areas and, as ordinates, pressure in pounds per square inch.

A similarity in the graphs of all the metals was immediately apparent. Not only did the curves of each group show similarity among themselves, but they were distinctly like the members of the other groups. That there was a common quadratic relation between them was very evident and they differed only by a single numerical constant. Study led to the conclusion that the rupture points of diaphragms of pure metals, uniform in thickness, homogeneous in structure, and at atmospheric temperature, follow the function $P = C/D$, where P is the rupture stress, C is a constant and D is the disk diameter. This expression is similar to the equation of an hyperbola which is referred to its asymptotes as axes of coordinates.

The chemical contents of the vessel, which positively fixes the atmosphere to which the disk is subjected, is a first consideration. Since safety disks are made, necessarily, of very thin material, gaged by thousandths of an inch, any chemical attack, no matter how little, destroys the disk's physical rating and so the essential feature is that the material must be immune from corrosion. This in many cases so limited the choice left to the engineer that it was difficult to work out a diameter and thickness of a given material to suit the required rupture point of the particular operation. In addition to this was the fact that there were vessels operating under widely different pressures, but having exactly similar atmospheres. At lower pressures, a metal of low tensile strength must be used, to avoid a cumbersome diameter, while in high-pressure vessels, a metal of high tensile strength must be selected, so as not to restrict the relief opening. Such a condition, to be met with a fair degree of certainty, demands at least two or more metals that are equally immune from chemical attack. Each must have physical characteristics of great difference, since the selection of either must insure against premature discharge, causing loss of valuable material; while, on the other hand, the disk must rupture at a given pressure, to prevent destruction of the vessel.

The type and quality of metals at our disposal at that time were so limited that subterfuges had to be resorted



Figs. 1-4—Breaking-stress curves for annealed, pure metal diaphragms of various constant thicknesses, using air at atmospheric temperature

to, such as interposing a "goose neck" of oil to protect the disk against the gases of the vessel, or a pad of paraffin on top of the disk, to prevent seepage from the discharge header attacking it. Such expedients would not be required if, on further investigation, materials suitable both chemically and physically, for each operation, could be found.

Having in mind the original contribution of the Bureau of Standards, together with our early experiments with frangible disks, some five or six years ago we outlined a proposed method of procedure for the further development of this subject, including the refinement of disk materials; the extension of the investigations to precious metals other than silver; the verification of our earlier conclusion to avoid the use of alloyed metals; and, finally, the mathematical determination of the rupture points of pure metal diaphragms.

Refinement of Disk Material—Through the generous cooperation of one large nickel producer and a subsidiary rolling plant of the same company, we have been able to raise the purity of our nickel strips from 98.5 to 99.5 per cent, and have greatly improved the method of annealing the finished product, by determining the breaking point from samples, previous to the final annealing.

By this careful handling, the improved ductility has enabled us to hold pressures within 2 per cent of the breaking point almost indefinitely at atmospheric temperature, showing wonderful tenacity, a condition much to be desired in this class of protection in preventing premature discharges. In our early work, failure to attain this satisfactory performance kept us in constant difficulty with our operating superintendents; now this disturbance has been practically overcome. Such refinement in production has also greatly improved the accuracy and regularity of the breaking point.

Our mathematical determinations of the breaking point are now much closer to the practical results. This has, of course, been due to the improved regularity of the ultimate strength, a factor of major importance in our calculations.

We believe that the 0.5 per cent impurity in nickel is largely cobalt and is considered inconsequential.

Use of Other Precious Metals—We have added to our material for this service both 24-carat gold and No. 1 platinum. Gold, however, has been eliminated, not because of inability to meet its requirements, chemically and physically, but because platinum is better constituted as a metal to resist chemical attack than gold, and has a distinctly wider range, chemically and thermally. The melting point of gold is 1,950 deg. F., as against 3,190 deg. F. for platinum.

Of equal importance is the fact that the price of gold has risen greatly and that of platinum has fallen even more greatly, so that their price difference per ounce is now insignificant.

These two very important facts naturally were sufficient to cause the adoption of platinum as a most superior rupture disk material. Its scrap value is also high, which tends increasingly toward its use in this field of industrial work.

As a rupture disk material, platinum is inferior to no metal in the protection to unfired pressure vessels, particularly those used in the manufacture of refrigerants, such as sulphur dioxide and dichlorodifluoromethane. The hydrofluoric acid encountered with the latter presents the most serious corrosion problem to disk material, and we have found that platinum is absolutely impervious to attack both by this and by SO_2.

Comparison of Discrepancies in Breaking Pressures of Alloy and Pure Metal Diaphragms

Metal or alloy	Nichrome	Nickel	18-8 Steel
Disk Diameter, Inches	2¼	2¼	2¼
Disk Thickness, Inches	0.009	0.009	0.015
Breaking Pressure, Lb. per Sq.In.	1,050	730	2,300
	925	725	1,825
	1,060	720	1,775
	1,025	730	2,165
	950	720	1,950
	1,050	730	1,875
Variation, Per Cent	14.6	1.4	28.0

Metal or alloy	Phosphor bronze	Copper	Yellow brass
Disk Diameter, Inches	2¼	2¼	2¼
Disk Thickness, Inches	0.011	0.011	0.011
Breaking Pressure, Lb. per Sq.In.	940	510	890
	900	515	875
	950	510	900
	925	505	875
	940	510	850
	925	515	875
Variation, Per Cent	5.5	1.96	5.9

Metal or alloy	Duralumin	Aluminum
Disk Diameter, Inches	2¼	2¼
Disk Thickness, Inches	0.011	0.011
Breaking Pressure, Lb. per Sq.In.	800	210
	725	210
	835	212
	650	210
	800	212
	750	210
Variation, Per Cent	28.4	0.95

Metal or alloy	Silver solder No. 8	Fine silver	Silver solder No. 24
Disk Diameter, Inches	2¼	2¼	2¼
Disk Thickness, Inches	0.013	0.013	0.013
Breaking Pressure, Lb. per Sq.In.	925	483	800
	875	485	825
	900	483	790
	825	480	850
	875	485	925
	900	483	850
Variation, Per Cent	11.1	1.03	15.3

So important has platinum become in this work that we are hoping, by careful homogeneous welding between thin platinum and nickel sheets, to cover the entire range of this important service with these two metals, used separately and in combination.

While platinum has a high melting point, its tensile strength is only about 22,000 lb., while that of nickel is between 50,000 and 70,000 lb. after annealing; thus these metals answer the dream of our pioneer work, described earlier in this paper.

Difficulties With Alloys—In order to determine the reason for the unreliability of alloys, a critical review was made of all of the available rupture data, and likewise examinations were made of failed rupture disks. All of the data obtained to date show rather conclusively that, in general, alloy materials cannot be depended upon to give uniform rupture values, whereas pure single metals do give uniform values. The reasons for these facts may be explained from the metallurgical point of view.

In pure metals, we have one continuous solid phase. In this condition, the properties of the metal are uniform throughout and there are no segregations, such as secondary phases, which will have different physical properties. In pure metals, different groups of grains will exhibit the same ductility, hardness and tensile strength. The result is that when pressure is applied and the rupture disk is bulged out, there is a resultant uniform thinning of the metal. This uniform thinning of the metal is dependent upon equal distribution of stresses in the metal and, consequently, when a given test is repeated a number of times using identical disks of pure metal, rupture will take place under the same pressure load. This point has been established by many trials and the result has been that in all cases where pure metal has been used,

the variation between independent tests is practically nil.

In the majority of alloys, however, there is not a complete homogenity of the metal components. The result is that the nonuniform distribution of the elements effects a variation in physical properties. In some cases, as, for instance, duralumin and phosphor bronze, there are definite compounds which segregate in the alloys. These segregations are usually harder than the main portion of the metal and are nearly always of lower ductility. When thin sheets of these alloy metals are stressed, as in rupture disks of the bulging type, there is an uneven distribution of the stresses, owing to the fact that the more ductile areas are thinned out first and the least ductile areas are thinned out the last. The result of this uneven relieving of the stress as the metal gives way to the force applied causes rupture to take place under varying loads. The probable reason for this is that segregations, as, for instance, intermetallic compounds in the alloy, have a smaller influence on the rupture pressure if the segregation is near the center of the disk (where the thinning of the metal is most noticeable). Then the variation in the pressure necessary to cause rupture will be more pronounced.

The accompanying tabulation, showing the rupture points of seven different alloy metal sheets, compared with the pure principal metals, emphasizes the greater reliability of the latter.

In general, it is quite probable that the variation in solid-solution alloy is due largely to the two factors influencing grain size, which factors, it is obvious, have a direct influence on the ductility and tensile strength of the metal.

Mathematical Determination—The determination of the rupture point of diaphragms by calculation in advance of their application begins with the design of flat circular plates exposed to pressure, where the plate is held securely at the circumference. From this we have:

$$\frac{\pi D^2 P}{4} = \pi D t S \qquad (1)$$

$$DP = 4tS \qquad (2)$$

$$P = \frac{4tS}{D} \qquad (3)$$

wherein D = diameter of the disk, P = breaking pressure, in pounds per square inch, t = thickness of disk material, in inches, and S = the ultimate strength, in pounds per square inch.

It will now be shown that an equation of the form of (3) applies to the ruptured disk when S is replaced by S', which represents the "bulging strength" of the disk, also in pounds per square inch.

First, it has been proven experimentally beyond a shadow of doubt, by actual measurements from disks carefully broken with water, that a bulging disk is a true spherical zone. The area of such a zone is

$$A = \frac{\pi}{4}(D^2 + 4h^2) \qquad (4)$$

where D is the diameter of the base of the zone and h is its height. Now, since the resultant of the vertical components of the radial pressure under the bulging disk (gage pressure) equals the total pressure tending to burst the disk, then from equations (1) and (4)

$$\frac{\pi D^2 P}{4} = \frac{\pi}{4}(D^2 + 4h^2) R$$

or

$$R = \frac{D^2 P}{D^2 + 4h^2} \qquad (5)$$

where R represents this resultant. That equation (5) is correct can be proven on a different basis by means of the calculus. (*Editor's Note*—The foregoing is all derived rigorously in the original paper.) Hence, from equation (5)

$$(D^2 + 4h^2) R = PD^2$$

and

$$PD^2 = 4tS'D$$

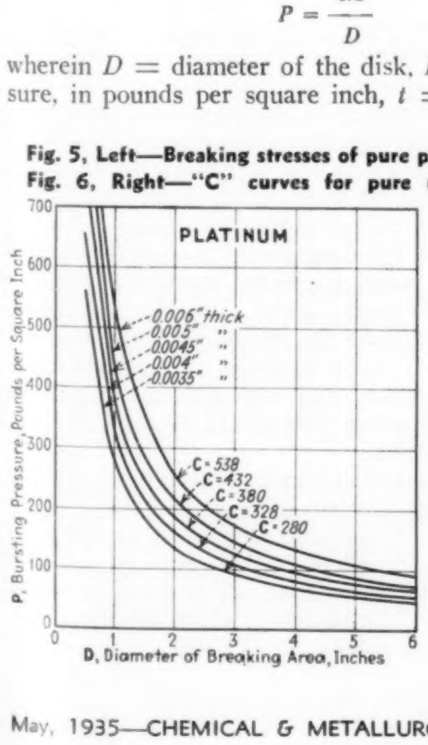
or

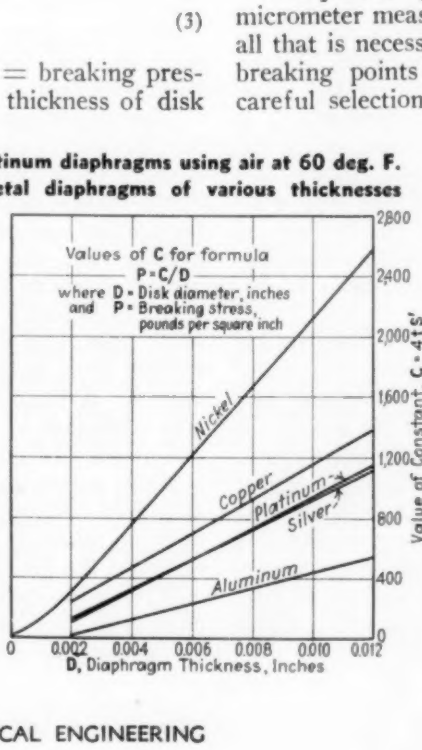
$$P = \frac{4tS'}{D} = \frac{C}{D} \qquad (6)$$

where S' is the bulging strength, as noted above, and C is a constant. The bulging strength is equal to the ultimate strength, S, multiplied by the sine of the angle made between the tangent to the bulging surface and the breaking diameter. Since we are unable to measure this angle after a disk has ruptured, we must take empirical values for S'.

In equation (6) the value of t may be obtained by micrometer measurement, while D is known. Therefore, all that is necessary to be able to compute accurately the breaking points of metallic diaphragms is to make a careful selection of values for S', by actual experiment with breaking disks. The data should be graphed for each independent thickness, plotting the integral values of the constant, $4tS'$ (or C), as ordinates, against the thickness of the metal as abscissas. For each pure metal this will give a straight line, as in Fig. 6, which, accurately extended, will cover a wide range of thicknesses. By interpolation in such a series of straight lines the value of the constant, C, for any particular metal and thickness may immediately be determined, and this substituted in equation (6) will give the value of breaking stress that may be expected for any given diameter. The results so predicted will, with careful preliminary work, be accurate within 2 per cent of the actual breaking point.

Fig. 5, Left—Breaking stresses of pure platinum diaphragms using air at 60 deg. F.
Fig. 6, Right—"C" curves for pure metal diaphragms of various thicknesses





Chemical Engineering Developments Discussed at Wilmington

EDITORIAL STAFF REPORT

THE twenty-seventh semi-annual meeting of the American Institute of Chemical Engineers is in progress at Wilmington, Del., as we go to press. Abstracts of some of the engineering papers presented at the convention are given below, while abstracts of others and news of the meeting will appear in the June issue. The paper on frangible disks as protection for pressure vessels, by Morgan E. Bonyun, of the dye works, engineering department of E. I. duPont de Nemours & Co., appears slightly abbreviated on pages 260-63 of this issue.

Handling of sodium on the industrial scale, with examples of its use in chemical reactions, was the subject of a paper presented by P. J. Carlisle, of the R. & H. Chemicals Dept. of E. I. duPont de Nemours & Co. Sodium is available in cast bricks weighing 1, 2.5, 12, and 24 lb. The two smaller sizes are packed in sealed, air-tight tins, the larger bricks in heavy drums. These packages may be stored indefinitely in dry storage rooms.

For most industrial purposes the 12- and 24-lb. bricks may be fed directly into the reaction systems. However, for some smaller scale operations it may be desirable to use small pieces, in which case the bricks may be cut or remelted and cast into the shape and size desired. This melting can be done in a small, round-bottom cast iron pot with drain and loose-fitting steel cover, with arrangement for maintaining an inert atmosphere in the pot. Heating may be by direct fire, or preferably by hot oil circulated in a jacket, or by electric resistance heaters.

Rods, ribbons, and wire may be made in the usual sodium press. A comparatively recent development is the shipment of solid sodium in tank cars, of about 80,000 lb. capacity, which may be filled in 16 hr. and melted and unloaded in 13 hr. The car has steel coils welded on the outside surface through which cold oil is circulated during the filling and hot oil while unloading. In filling the air is displaced with nitrogen prior to admitting the sodium.

The choice of method for introducing sodium into a reaction depends on the conditions involved. In many cases, all of the sodium may be used in a batch operation, added at one time. Where the progress of the reaction is not controlled by the rate of addition, bricks, cubes, rods, and so forth, may be added directly without any particular precautions to keep the metal from contact with air. In cases where sodium is used in a continuous process and the rate of reaction is controlled by the sodium the bricks are added at predetermined intervals, or sodium may be melted in an inert atmosphere and fed through a valve into the system.

In plants where large quantities of sodium are transferred from one point to another this may be done by melting the sodium and conveying it through a pipe line. In one installation, sodium has been conveyed for over two years in a 2½-in. welded standard iron pipe line, about 1,200 ft. long. Heating of this pipe is done by means of an electric resistance, consisting of a welded ¼-in. steel pipe mounted parallel to the pipe line and insulated from it. Sodium is caused to flow through the pipe line by applying a partial vacuum to the outlet end. The flow is intermittent but the normal rate is about 6,000 lb. per hour. On occasions this flow has been as great as 20,000 lb. per hour, obtained by the use of a higher vacuum. Normally a vacuum of 28 in. is used.

Induction Heating

How to apply and design induction heating for chemical process equipment was discussed in a paper by Charles E. Daniels, of E. I. duPont de Nemours & Co. Fundamentally the electric induction heater is a transformer, poorly designed from the electrical engineer's standpoint, but very efficient from the chemical engineer's point of view. The electrical winding wrapped around the circumference of the chemical vessel is the primary, the vessel itself the combined core and secondary. The total of the energy passing into the hysteresis losses, eddy currents, and the short-circuited secondary appears as generated heat in the vessel itself.

The advantages obtained in this type of heating are ease of control and the high temperature attainable. Frequently some peculiarity in the design of the chemical vessel makes jacketing or direct firing inadvisable. Although the equipment cost of induction heating is usually greater than that of resistance units it should be used in preference to the latter where the operating temperature or difficulty of contact make fabricated resistance units unsuitable and where the difficulty of securing the desired input by other methods makes its selection mandatory. A supplementary, although generally not decisive advantage of induction heating lies in its uniformity and absence of hot spots.

After having analyzed the heating problem and selected induction heating, the problem of designing the winding must be taken up. The rational method of design is to calculate the heating produced by hysteresis in the iron core, by eddy currents in the core, and by heavy induced current in the shell. The variables which must be fixed by the designer are the voltage, size of wire, arrangement

of the turns, both with respect to each other and to the vessel, number of turns, and mechanical support for the winding.

It is well to point out that the wire size selected should not be too small, as a simple calculation will show that at the higher amperages an appreciable loss can occur in the winding. A good rule for average practice is to follow the regulations of the National Board of Fire Underwriters for interior wiring for "Other Insulations" in selecting the wire size.

Harry A. Curtis, chief chemical engineer, Tennessee Valley Authority, in his paper on the manufacture of phosphoric acid by the electric furnace method pointed to the great problems with which the T.V.A. is wrestling in the prevention of soil erosion in the Tennessee Valley. A readjustment of agriculture directed toward elimination of soil erosion calls for use of phosphate fertilizers in new ways and on many areas formerly not fertilized.

Late in 1933 it was decided that one item in the T.V.A. fertilizer program would be to explore the possibility of the production of phosphoric acid and a concentrate superphosphate through the design and construction of at least two electric furnaces. The first of these, a 6,000-kw. unit, was put into operation in November 1934; the second furnace, also 6,000 kw., was started in January of this year.

Phosphate rock is delivered to the plant by rail from the phosphate field of middle Tennessee, and by barge to Wilson Dam from Perry County, Tenn. It is crushed to minus 2 in., dried, screened, and the oversize fed to the furnace. The fine material is used in the production of superphosphate. Coke is purchased in the Birmingham district. An attempt to use coke breeze did not prove successful. Silica is obtained from Iuka, Miss. A typical furnace charge is composed of 2,000 rock, 718 silica, and 324 coke.

The gas issuing from the electric furnaces, a mixture of carbon monoxide and phosphorus vapor in ratio 10:1 by volume, is burned with excess air, cooled and hydrated. The acid from both plants is collected in acid tanks and pumped to the fertilizer manufacturing building.

Precious Metals for Equipment

One of the most important characteristics of the platinum metals to the chemical engineer is their high resistance to attack by acids and other chemical agents, Fred E. Carter, of Baker & Co., stated in his paper on the use of precious metals as materials of construction.

Alloys of platinum with iridium, osmium, rhodium and ruthenium are all solid solutions and they are, as would be expected, increasingly resistant to aqua regia as the amount of added metal is increased. Alloys of platinum and palladium dissolve more readily than platinum, but it is interesting to note that although palladium dissolves easily in nitric acid the platinum-palladium alloys containing up to 25 per cent by weight are practically unattacked.

Carter stated that it is perhaps well to draw attention to the fact that the use of platinum in chemical equipment need not be confined to very minute parts. It is quite feasible to make large vessels, tubing, etc., of the precious metal. The initial cost is naturally higher than if base metal alloys are used but it should not be forgotten that the resale value of platinum is very high. Practically any shape can be easily made, and finally there is the peace of mind obtained by the assurance that the vessel will have a long and healthy life.

Some very important electrochemical processes use platinum or preferably platinum-iridium alloys for the anodes, details of which cannot be given here. Due to the immunity from attack the necessarily large sheets can be made quite thin with the resulting ease of handling. The value of such completely resistant anodes in the manufacture of a pure product is obvious.

For certain chemical processes the complete apparatus is made of fine gold. The use of the pure metal may sometimes be necessary but it has the disadvantage that it is quite a soft material and is easily distorted. In order to increase its resistance to distortion it is necessary to alloy the gold with other materials. The addition of platinum metals to the gold is rather obvious since these rapidly increase the hardness and do not decrease but rather increase the resistance to chemical attack.

How to Use Semi-Works Plant

How to use semi-works plant was the subject of a paper presented by C. J. Darlington and Chester H. Ahlum, in which specific attention was given to the semi-works plants connected with the Jackson Laboratory of E. I. du Pont de Nemours & Co.

When decision has been made to look into the development of a new product the first step is a preliminary cost estimate. It is the job of the semi-works engineer to provide this cost estimate on the basis of such information as may be obtained from the research laboratory. In some cases, the estimate is a routine affair because a similar product may be produced in the existing manufacturing plants. Where this is not the case, however, the problem is more difficult; here the consulting mechanical engineer enters the picture, to furnish a probable cost of building and equipment. With the cost figure thus provided the chemical engineer may complete the preliminary estimate.

Provided the outlook is satisfactory the research chemist then undertakes the laboratory development. With the information made available by this research a new cost estimate is now made by the semi-works engineer. This estimate includes both the probable cost of producing a small preliminary lot in the semi-works and also the probable cost of future plant manufacture.

When the preliminary research work and the cost estimates are accepted by the management, the order for the first lot is placed and the operation of the semi-works plant is started under the supervision of the research chemist.

If the desired results are not obtained with the completion of the preliminary lot the course to be followed depends somewhat on the nature of the difficulty. If the need of further laboratory work is indicated the research chemist takes up this investigation and operation is suspended until new results are obtained, whereupon semi-works production is resumed.

When a successful lot has been produced the operation is turned over to semi-works supervisor for future production, the research chemist serving in an advisory capacity. After a standard procedure has been reached a final cost estimate is prepared by the chemical engineer,

which is used until a change is made in the operation. Such a change may consist in a transfer of the operation to full plant size scale. When plant production is started the research chemist follows it in detail until satisfactory operation is obtained.

Pilot plant operation was discussed in a paper by F. C. Vilbrandt. In general, this term is used to designate a phase of the engineering experimentation on a project originating or emanating from a research laboratory with the expectancy of creating a commercial chemical plant.

The pilot plant must be capable of operating over relatively long periods under conditions which are not changed frequently, to obtain fair approximation of labor costs and manufacturing expenses. Pieces of equipment selected specifically for the work to be performed is a monetary saving in the long run. The pilot plant should not be dismantled until such time when it is safe to assume that the full scale plant is capable of consumer testing; also, it should be available for some time to study certain suggestions regarding changes in the process, without costly interference with the commercial production.

Individual conditions determine the proper size of a pilot plant. It should be large enough to indicate something of the cost and quality of the labor required for the commercial operation. In addition, the efficiency of the equipment under average conditions of plant operation should be determined from this pilot unit. The proper size is the smallest unit that will actually duplicate working conditions of the large plant. However, even with the most careful thought it may later be found that the unit is not sufficiently large; if there is any doubt in the matter the erection of a larger unit as a further precaution before proceeding to full scale is absolutely recommended. The acid test of a pilot plant is a smoothly and economically operating commercial plant designed therefrom.

Buildings, if required for a pilot plant, may be more or less of a permanent character, cheaply erected and easily expandable to take care of inevitable alterations that generally are required. Frequently a process may be set up in the open with just those units covered where weather conditions might affect the equipment or make working conditoins uncomfortable.

Improvement of Refractories

A narrowing and more critical market is cited as a stimulus for the improvement of refractories. These have been developed by several novel principles in manufacturing namely, (1) grain sizing, increased molding pressures as high as 10,000 lbs./sq.in., de-airing of the batch, pre-stabilizing the grog, developing high crystallinity by super firing, direct electrocasting of refractories, and the Ritex process in which firing is entirely eliminated.

The newer refractories, including super-duty fireclay, mullite from cyanite, electrocast mullite, chrome spinel and magnesite, a magnesite substitute from olivine, unburned magnesite and chrome brick, insulating firebrick, and castable mixtures with a hydraulic set, were discussed in a paper by Louis J. Trostel.

The improved refractories, it is pointed out, are making possible better applications of materials, particularly where basic fluxes and oxides are present. Magnesite is displacing fireclay and high alumina brick for cement kiln linings, and glass regenerator checkers. Electrocast and bonded mullite are replacing clay for glass tank flux blocks. Silica is losing its importance for sidewall, port-end construction and roofs of metal melting furnaces, because of improvements in the physical character of basic brick. Insulating firebrick, while effecting heat economies to the user, are creating new problems for the refractories producer. Better clay brick checkers, a quick-setting magnesite grain for furnace bottoms, magnesite ladle nozzles to replace clay, and the use of the super-duty fireclay brick for certain heating conditions involving severe spalling and slagging, are also referred to.

A New Material of Construction

A NEW SERIES of products, plasticized vinyl halide, designated by the trade name Koroseal, has been announced by J. W. Schade, Director of Research of The B. F. Goodrich Co. These products have been perfected after extensive experimentation. They comprise products varying in hardness from that of hard rubber to soft jellies. The harder varieties may be lathe cut, bored, and threaded, and all compositions may be molded to any shape, extruded, or sheeted.

Koroseal compositions possess properties that adapt them for use as a resilient rubbery material where rubber itself fails to meet conditions of service. These new products are said to be superior to rubber in resistance to corrosive liquids such as mineral acids and to certain oils. They are superior to rubber, also, in flexing life and in resistance to sunlight and water. They exhibit unusual resistance to natural or accelerated aging and natural or induced oxidation. They are substantially odorless, tasteless, and flame-proof.

This new material is resistant to: sulphuric acid in all concentrations at room temperature; nitric acid in all concentrations at any temperature up to the boiling point; hydrochloric acid over its entire range of concentrations and boiling points; alkalis in all concentrations, cold or hot; plating solutions of all kinds; 30 per cent hydrogen peroxide; saturated chlorine water; 10 per cent sodium hypochlorite solution; saturated aqueous sulphurous acid; oleic and lauric acids.

In light and heavy oils Koroseal shrinks and stiffens slightly. These changes are accelerated as the temperature is raised. It is not recommended, therefore, for immersion in gasoline or oils, organic compounds containing chlorine or nitro groups, aliphatic or aromatic amino substances. For service where a minor portion of surface is exposed to oils, however, as with gaskets or sealing rings, it has given excellent results and long life.

The useful temperature range of these compounds varies from approximately 13 deg. below zero to 257 deg. F. Generally, however, they are not recommended for any higher temperature than 150 deg. F. without special approval from the factory. The unique properties of Koroseal suggest a variety of uses, many of which already have been investigated. Further developments are in progress.

Packaging and Shipping Dangerous Chemicals

By R. W. LAHEY
American Cyanamid Co.,
New York, N. Y.

NO ONE will dispute the fact that transportation of dangerous articles is a function that should be well regulated in the interest of public safety. Few, however, seem to realize that the regulations governing this transportation have the force of law, and that severe penalties have been provided for violations. This being a fact, a thorough knowledge of these regulations is highly essential for all those engaged in the manufacture, shipment, and transportation of such articles.

Congress, recognizing this need, enacted legislation in 1908 which was subsequently amended on March 4, 1921, an act generally known as the Explosives Act.

The Interstate Commerce Commission was directed by the 1921 law to formulate regulations for the safe transportation of explosives and other dangerous articles, specifically including inflammable liquids and solids, oxidizing materials, corrosive liquids, compressed gases, and poisonous substances. These regulations are binding upon all common carriers engaged in interstate or foreign commerce both by land and by water. The Commission is authorized either of its own volition or upon application of any interested party to make changes or modifications in said regulations which may become desirable because of changed conditions or discovery of new data. It is specified that the regulations and all changes therein, unless otherwise noted, shall take effect 90 days after publication and shall remain effective until reversed, set aside, or modified by the Commission.

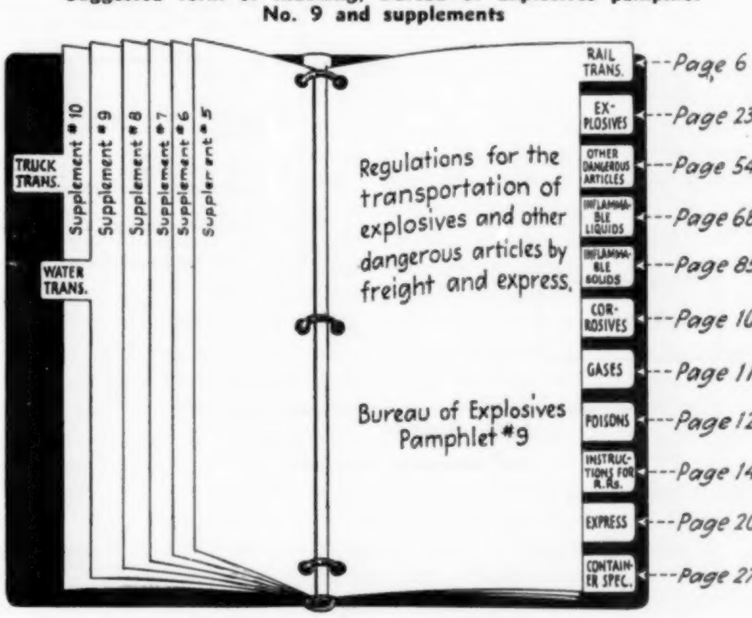
This act is binding on all common carriers engaged in interstate or foreign commerce as well as on all shippers making shipments via such carriers. Whoever knowingly violates the act or the regulations promulgated by the I.C.C. shall be fined not more than $2,000, or imprisoned not more than 18 months, or both. If death or bodily injury result, the fine shall be not more than $10,000, or imprisonment not more than 10 years, or both.

The act authorizes the I.C.C. to utilize the services of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles (known as the Bureau of Explosives) as well as any of the U. S. Government departments, commissions, boards, or officials.

As the I.C.C. does not include any technical representatives and as the adoption of and changes in the regulations come under that section of the Commission which is supervised by the Director of Bureau of Service, who has many other duties, it was necessary to take advantage of that portion of the Act of Congress which authorized the Commission to utilize the services of the Bureau of Explosives.

The Director of Bureau of Service as a general rule will accept any recommendation that may be made by the Bureau of Explosives relative to changes in the existing regulations. This results from the fact that the Bureau of Explosives through its many years of experience is extremely well equipped technically both as to engineering staff and laboratory facilities to handle this work.

Suggested form of indexing, Bureau of Explosives pamphlet No. 9 and supplements



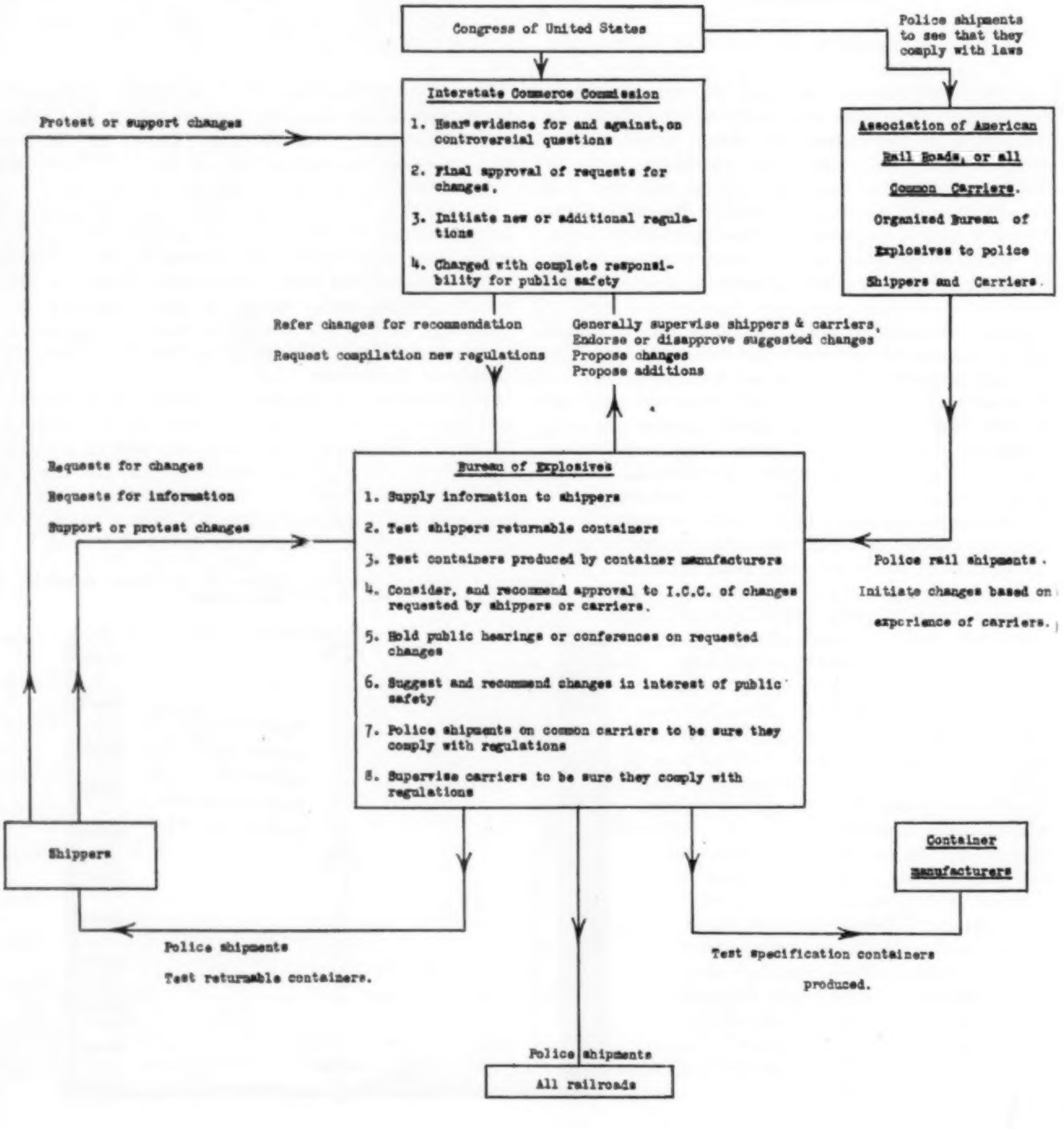
Most people who do not have an intimate knowledge of this matter believe that the Bureau of Explosives is a government department, but this is not the fact. The Act of March 4, 1921, states that the railroads must abide by the regulations and see that they are carried out. Therefore, in order to meet this obligation, they organized the Bureau of Explosives. The bureau is largely supported by the railroads, although some steamship companies, express companies, and shippers contribute to its maintenance. In no case, to my knowledge, have they ever made a recommendation which unfairly discriminated against any form of transportation other than rail. The staff of the bureau is of the highest integrity and deserves the commendation of the chemical industry for the way in which they have handled their work over the many years of their existence.

The bureau cooperates with industry to the fullest extent possible. They are sympathetic to the work and aims of the several technical container committees of the Manufacturing Chemists' Association and actively cooperate in their work.

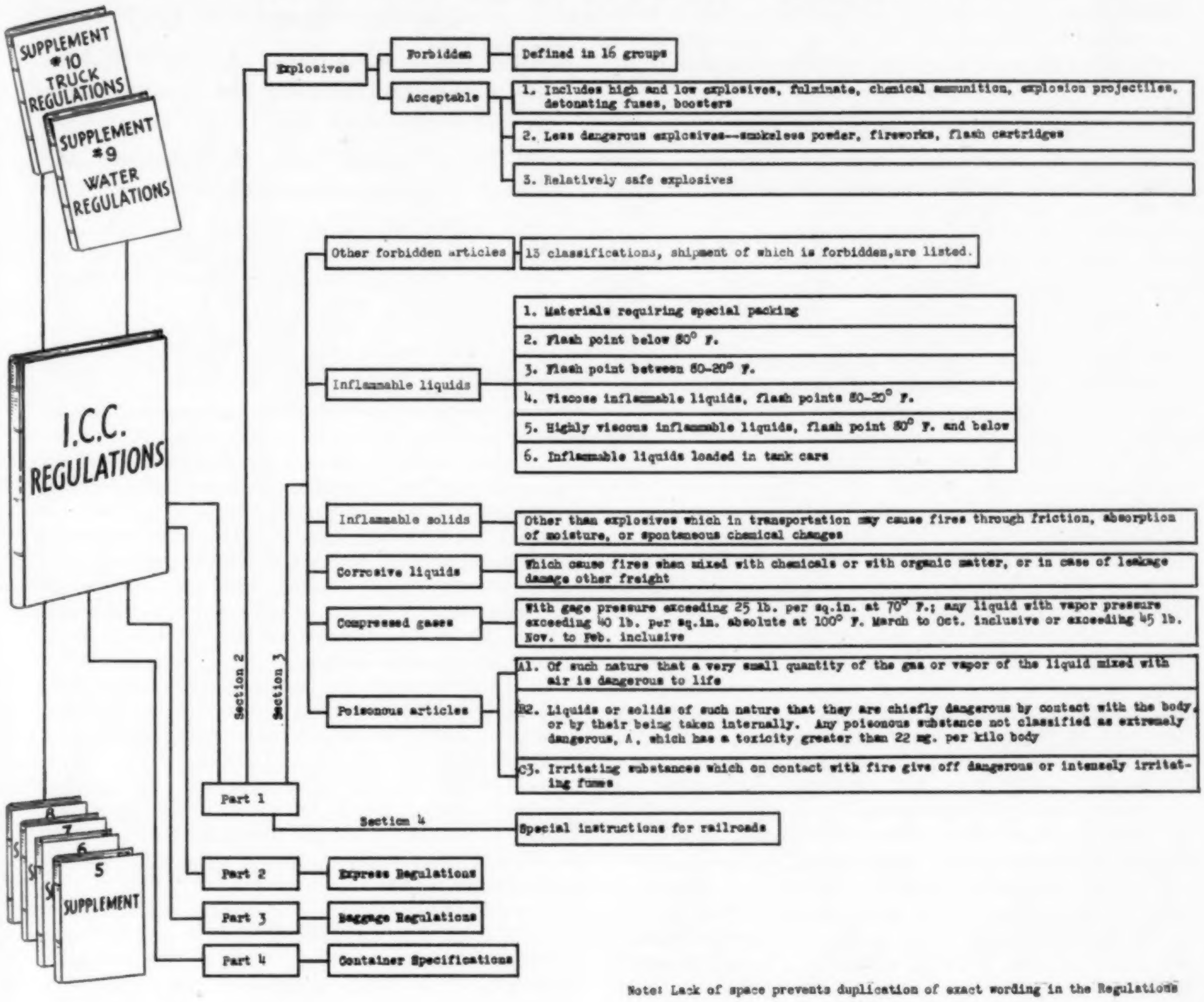
The Act of Congress of March 4, 1921, is somewhat ambiguous in that it does not define all of the terms which are used in the law. For instance, it is stated that the act is binding on all common carriers engaged in interstate or foreign commerce by land or water. Although there is no definition of the term "common carrier," which it is the duty of the courts to decide in each instance, it is generally assumed that any transportation facility which is for public hire is a common carrier.

These regulations are necessarily involved as they

Duties of regulatory bodies in transporting dangerous materials



Regulations for transportation of explosives and other dangerous chemicals



Note: Lack of space prevents duplication of exact wording in the Regulations

cover detailed container specifications and shipping regulations for a vast number of materials of widely differing characteristics. Shippers and carriers may have difficulty in understanding and using the regulations because they are not familiar with their structure. The chief aim of this article is to explain the construction of the regulations and thereby to aid in the understanding of them. It is also intended to acquaint one with the organizations charged with the responsibility of making, enforcing and changing the regulations. It is hoped that some of the existing misunderstandings will thereby be corrected and that the intent behind this law will be more clearly seen.

It is not the policy of the bureau to further complicate the shipping regulations by writing additional specifications for the transportation of new products unless it is evident that a real hazard exists. Therefore the shipper need not hesitate to discuss with them questions involving the transportation of new products.

All shippers of dangerous articles should have available for reference Bureau of Explosives Pamphlet No. 9, revised to Oct. 1, 1930, which is known as I.C.C. Regulations for Transportation of Explosives and Other Dangerous Articles by Rail, by Truck, and by Water. Subscription to the pamphlet covers all supplements and additions thereto, which at the present time includes ten supplements. The subscription also includes all supplements and additions which may be issued from time to time in the future. Pamphlet No. 9 may be obtained from the Bureau of Explosives located at 30 Vesey Street in New York City, for the nominal amount of $2. In order to facilitate the use of these regulations, as a quick and ready reference, it is recommended that they be placed in a ring binder in the order specified and indexed as explained in an accompanying illustration.

The suggested indexing and reference notations on changes, are used by some of the best informed shippers and have been found to facilitate the use of the regulations.

The supplements should be filed in the binder in front of the other data, and at the present time there will be required supplements Nos. 5 (which includes 1, 2, 3, and 4) 6, 7, 8, 9, and 10. Supplement Nos. 9 and 10 cover the water and truck regulations, respectively.

It is recommended that notations be made in the margin of the regulations, next to those portions which have been changed, deleted, or added to. These notations should show the number of the supplement in which the modifications occur. Thus will be provided a binder that can be readily used without confusion, and with the assurance that there will be a notation if any change or addition has been made in the original text. It is hoped that some day the Bureau of Explosives will print all additions and supplements to the regulations on one side of the sheet only. This will allow one to cut out each change and paste it in that portion of the original book to which it refers. This system is in force for the Army Regulations and the Quartermaster Regulations, and it is effective and has proved to be a great time saver, provided it is kept up to date at all times.

The regulations are divided into three main classifications:

(1) Shipments by rail.
(2) Shipments by motor truck or other vehicle.
(3) Shipments by freight or freight-and-passenger vessels.

The classification which covers rail shipments is the basis for all regulations and the other two classifications cover in detail those regulations which are peculiar to shipments by public highway and water. On all other matters they refer to the rail regulations.

The truck regulations cover in detail questions of shipping papers, attendance of truck drivers and parking, truck equipment such as mufflers, fire extinguishers, lighting, loading, and other precautions. They give detailed specifications and regulations for truck tanks.

The water regulations deal principally with questions of proper stowage, shipping papers, those vessels which are authorized to carry dangerous articles, and other matters having particular reference to water shipments.

The rail regulations classify the various dangerous articles into groups, such as inflammable liquids, corrosive liquids, and so forth. There is a definition of the characteristics of articles in each group, and many of the well-known materials within the groups are listed. Some doubtful or borderline products are included. The shipper cannot assume that his product is not classed as dangerous if it is not specifically listed, but before shipment of an article he must make his own decision based on the definitions. Materials of special characteristics have individual regulations for those products only, while others come under general regulations for the particular classification. Some of the general classifications are subdivided into sub-groups, depending on the degree of danger encountered in shipping the commodities in the classification. It is therefore necessary to be familiar with the make-up of each classification of the regulations as well as the complete sections containing this information. The accompanying chart shows the structure of the shipping regulations and gives definitions of the principal groupings and sub-groupings.

There is a chapter devoted to special instructions for the railroads which covers various matters of particular interest to the carriers. This section includes such subjects as marking, labeling, handling, shipping papers, and other important points. It is recommended that the shipper read the section as it contains much worthwhile information.

Express regulations are covered in a chapter devoted to this subject. The information follows the same general outline as the freight regulations although the text differs somewhat from that of the latter. Some special precautions must be observed due to the difference in the type of service, and these are covered fully. It is not necessary to be familiar with this section unless one is shipping by express. There is another section devoted to baggage service but it is relatively unimportant to the average shipper.

Those portions of the regulations discussed thus far cover the definitions of the products, methods of packing prescribed, and the special precautions which must be observed, such as labeling and other details. The containers which are designated are shown by specification numbers without details as to their construction, and the last section of the volume covers the detailed specifications for each container and the tests which they must withstand.

Each container specification covers a package which may be used for transporting one or more dangerous materials; because of the differing characteristics of these materials certain changes in the details may be described in the body of the regulations. For instance, it may be necessary to solder the friction cover of a steel drum when it is used to transport a certain material and this extra closing safeguard is covered in the regulations rather than in the container specifications.

It is clearly the responsibility of the shipper to determine whether a commodity is dangerous and thereby subject to the regulations. This is often difficult to decide if the particular material is not specifically listed. One must consult the definition of the article or definitions of the classification of dangerous articles which the commodity most closely resembles. If it is not clearly evident that the material is or is not hazardous it is advisable to refer the matter to the Bureau of Explosives. The bureau has a great deal of data on many materials and it can probably supply the required information. If necessary it will make laboratory tests to determine the question.

From time to time it will be found that it is advisable to change a container because a better package has been developed. The use of such packages may not be authorized for rail shipment and this will involve changes in or additions to the regulations. The importance of the manner in which the application is made and the

Can You Answer This One?

Question: As a shipper of chemicals have you any suggestions for the simplification or clarification of the I.C.C. Regulations for the Transportation of Explosives and Other Dangerous Chemicals?

The editors of **Chem. & Met.** would like to have your answer to this question for publication in a **Reader's Forum on Chemical Packaging.** You are very cordially invited to participate in this discussion—to present your own problems or your solution to those proposed by others. May we hear from you?

data on which the request is based cannot be emphasized too strongly. Before approaching the bureau on a question of this type, exhaustive tests should be made to demonstrate that the new type of package is safer than the containers authorized by the regulations. It is absolutely necessary that this be proved without question as it is extremely poor policy to go before the bureau in support of a project that has not been fully investigated and where there is a possibility that further tests may bring to light unsafe features of the package. Questions involving the public safety must receive the utmost attention and the Bureau of Explosives will not be disposed to recommend changes in existing regulations without positive proof of their merits. A recommendation which has been completely investigated and which is accompanied by a comprehensive statement enumerating the reasons for the change and describing the tests which have been made to prove that the recommended container is adequate, cannot help but instill confidence in the minds of the bureau representatives. Experience has proven that this method of approach is much more acceptable to the bureau than if expensive legal representatives are employed to testify to and argue the legal aspects of the question.

A change or addition to the regulations must go through the following steps before it becomes effective.

1. Published on a docket of the Bureau of Explosives.
2. A conference at the office of the Bureau of Explosives is conducted on the docket.
3. Recommendations for or against the proposal by the bureau to the I.C.C.
4. Approval of the I.C.C. (With no opposition to the change the commission will sometimes approve the change without the formality of a public hearing. If there is opposition the commission may hold a hearing and will give the opponents of the proposal a chance to testify.)
5. Ninety days after published approval of the I.C.C., unless shorter time is authorized, the change becomes effective.

This complicated procedure naturally requires from 6 to 12 months from the time that a request is filed with the bureau until the change can go into effect. With this in mind shippers should not delay in filing their recommendations with the Bureau of Explosives. It must be borne in mind that any change requested for freight transportation does not include movement by express. If there is a possibility that express shipments are to be made, this should be included in the application.

In addition to all duties enumerated above, the Bureau of Explosives has the unpopular job of policing shipments. This is accomplished by the activities of a group of inspectors throughout the country who are continually watching materials prepared by shippers and shipped by public carriers and investigating all reported accidents. Perhaps the best example of the friendly attitude of the bureau to industry is the way in which violations are called to the attention of shippers. This is always done in a courteous manner, and a real spirit of helpfulness is in evidence.

In short, the problems which confront the Bureau of Explosives are many and far-reaching in character. An appreciation of this, together with an understanding of the objectives for which they are striving, must impress the shipper with the fact that this work deserves his hearty support.

Electrochemical Problems Discussed

THERE appeared in the March issue of *Chem. & Met.* (p. 148-49) abstracts of some of the papers that were presented at the New Orleans meeting of the Electrochemical Society. And the April number (p. 230) included a news account of this convention. Abstracts and discussion of other papers presented at this meeting are given below.

Dr. L. D. Vorce presided at the session on alkali-chlorine industry and Prof. R. A. Steinmayer of Tulane University introduced the subject with a fascinating account of the salt domes of Louisiana. Dr. Vorce emphasized the fact that the United States is well supplied with salt for the next 300 yr. Among those who took part in the long and animated discussion were Stewart J. Lloyd of the University of Alabama, Herman Schlundt of Missouri, C. B. F. Young of Birmingham, L. L. Hedgepeth of Philadelphia, and Colin G. Fink of New York.

A paper by W. W. Stender of the State Institute of Applied Chemistry at Leningrad, U.S.S.R., reported at length the qualities and methods of testing of asbestos diaphragms as used in alkali-chlorine cells. The Ural asbestos was found to be not quite equal to that from Canada. In his comments Chairman Vorce complimented the Russian chemists on the several valuable researches being carried out, notably in electrochemistry.

Prof. Hiram S. Lukens of the University of Pennsylvania presided at the session on electrothermics. The outstanding contribution at this session, and one that was heralded as a classic of its kind, was that on properties of carbon at arc temperatures, emanating from the Cleveland research laboratories of the National Carbon Co. The authors are N. K. Chaney, V. C. Hamister and S. W. Glass. A new fixed point on the high-temperature scale was established. It is the temperature of the carbon arc crater, namely, 3,810 deg. K. or 3,537 deg. C. Experiments were carried out in most careful and painstaking fashion. Results indicate that (1) carbon sublimes without melting at ordinary atmospheric pressure; (2) the temperature of the positive crater approaches a limiting constant value; (3) the maximum "brightness" temperature of the carbon crater is 3,810 deg. K.; (4) the wave length of maximum radiation intensity lies between 0.735 and 0.740 mu; (5) the probable true crater temperature lies between 3,925 deg. and 3,970 deg. K. The preferred conditions for insuring maximum crater brightness were established.

Another paper of this session of particular value to the electric furnace engineers was that by Dr. F. V. Andreae of Anniston, Alabama. He submitted a detailed series of tables which will permit the electric furnace designer to determine quickly the reactance of any large furnace of given dimensions and also to calculate the various characteristics of the furnace.

Readers' Forum on
CHEMICAL PACKAGING

EDITOR'S NOTE:
We are greatly encouraged by the enthusiastic response to our proposal that a "Reader's Forum" offered a practical approach to some of the many problems involved in the packaging and shipping of chemical products. Our first question brought forth more letters than can be published in this first group of answers. Summarizing them, we arrive at the following conclusion: Apparently no single factory test of a shipping container is conclusive or final, but is merely indicative of probable results to be obtained in actual service. For example there are drop tests, compression tests, tensile tests, tear tests, puncture tests, hydrostatic tests and moisture tests. In almost every instance shippers have reported experiences in which new types of containers have passed these tests satisfactorily, but after shipment some defect has come to light which was not detected in the factory tests. Are we safe in concluding, therefore, that a cardinal and fundamental principle of bulk packaging is that the only safe and sure container tests are actual shipping tests?
If you do not agree with this, we invite your criticism and discussion. If anyone can show this opinion is incorrect we want to know it. It involves a problem that has probably cost the industry more waste of money than any other phase of packaging. Here is the first question and some of the answers:

Question: What preliminary tests should be applied to a shipping container for chemicals to determine accurately whether or not it would prove satisfactory for this type of service? Are different tests used for bags, barrels, drums and boxes?

Some Good Preliminary Guides

REPLYING to your question regarding preliminary tests for shipping containers, my thought is that for any container such as a barrel, drum or box, a laboratory compression test should be run to determine the stacking qualities of the container in question. A drum test can also be run which will prove the all-around strength of the container. It is assumed, of course, that a check will have previously been made to cover the workmanship in putting the container together—a precaution that applies to bags as well as to barrels, drums or boxes.

No matter how satisfactory the results of these tests appear, however, there should always be a preliminary shipping test of the container filled with the actual material to be shipped in it and these tests should be made over a routing that will give the very hardest kind of wear and tear. A small shipment by boat is always a good test for it involves handling on and off the truck between the factory and the dock, handling on and off the boat in conjunction with a miscellaneous cargo, and if the boat is a small one, the shipment is apt to get thoroughly rough handling in transit. The above offers, in my opinion, a good preliminary guide as to whether one is on the right track in developing a new container that will perform satisfactorily in handling chemicals.

S. T. EDGERTON

Division Purchasing Agent,
United States Rubber Products, Inc.,
New York, N. Y.

Drop Test Satisfactory

WE BELIEVE that the standard drop test approved by the Bureau of Explosives is a reliable method of determining the structural strength of a container. This test provides that a container, filled as it will be presented for shipment, be dropped from a height of four feet to a concrete floor; one drop on each end of the container, allowing it to strike on the chime. Any package standing up satisfactorily under this test will certainly withstand any shipping test in so far as the strength of the package is concerned.

A. H. EUFER

R. T. Vanderbilt Co., Inc.,
New York, N. Y.

Best Guide Is Actual Experience

THE TEST which should be applied to a shipping container depends entirely upon the nature of the chemical. Any test, for example, as to the satisfactory qualities of a container for epsom salts would not be at all applicable in the case of a package for sulphur chloride and I think that in a general way, our experience has shown that the only safe method of determining these qualities is by actual shipping experience. Exceptions to this general rule, of course, are any special specifications which the Interstate Commerce Commission has laid down and which seem to cover the most of our shipments.

A. C. WHITE

Technical Sales Division,
Dow Chemical Co.,
Midland, Mich.

Manufacturer's Test Usually Satisfactory

IT HAS BEEN my experience that the manufacturers of containers do most of the necessary testing, and this is particularly true in the case of containers for chemicals which are required, under the Interstate Commerce Commission regulations, not only to be made according to specifications, but to have the manufacturer's certificate embossed or imprinted on the container after testing.

It is true that the Manufacturing Chemists' Association and other bodies have committees, but the function of such committees is to pass on the suitability of a type of container and in doing this they sometimes find it necessary to make a standard test. Outside of that occasional test, the matter is left to the manufacturers of the containers, as stated, and an inspection of a percentage of new containers received at the factory is generally sufficient to keep the manufacturer up to standard.

THOMAS O'DONNELL

Traffic Manager,
Mallinckrodt Chemical Works,
St. Louis, Mo.

M.C.A. the Best Forum

THE QUESTION ASKED in your March issue is very sweeping and I do not believe it is capable of a simple answer. In general, I do not think preliminary tests of containers or in fact of any merchandise will determine accurately whether or not that merchandise will prove satisfactory in service until and unless such tests are developed on the basis of actual service experience. Such tests are being developed slowly and among them I think the swing test for carboys has proved to be most reliable. On the other hand, in the case of other containers, I suspect that most manufacturers form

their opinion regarding serviceability from actual service experience.

In the development of preliminary tests I think that the work being done by the Carboy Committee and the Drum Committee of the Manufacturing Chemists' Association is most valuable. This work brings together the experience and development work of a large number of organizations for the comparison of data and for the conduct of actual testing. Personally I believe that this committee work constitutes the best forum for dissemination of information and the correlation of experience. Since you have asked my opinion, I will be so bold as to suggest that your magazine might attempt to act as spokesman for these committees in order to spread more widely the information they have gathered and to provoke discussion regarding conclusions.

J. P. Coe

Factory Manager,
Naugatuck Chemical Co.,
Naugatuck, Conn.

Firm Believer In Drop Test

PRELIMINARY tests of a container, whether for chemicals or not, should prove that the package delivers its contents to the consumer in the condition in which it left the manufacturer. The individual package, whether shipped as a unit or packed as several units to a larger container, should be capable of withstanding all the hazards of transportation and handling within the bounds of reason—plus a few more for good measure.

It will, of course, be evident that with the diversity of products and manufacturers, it is impossible to present more than a brief outline of a few general principles. Material should be classified first according to form, namely if a solid, whether powder or flake, or if a liquid, whether volatile, viscous, semiliquid, excessively mobile or penetrating. The products should next be scrutinized to see whether they fall into the class of explosives or flammable, poisonous or corrosive liquids, for which special types of containers are prescribed by the Bureau of Explosives. This examination should indicate whether or not the products are hygroscopic or have other special chemical or physical properties which must be considered in their packaging.

The best method of handling the products for packaging may also determine the character of the package. The package should reach the customer so that none of the contents is lost or leaks to the outside of the container. This not only disfigures the appearance of the package but may annoy the consumer in handling it. Remember that as long as the package carries your product and name, it is still an advertisement for your company and for the care and quality with which you pack your goods.

The writer does not feel that the tests for bags, barrels or drums and boxes need be materially different in general. I am a firm believer in the four-foot drop test described by the Bureau of Explosives. The packaging prescribed by them for dangerous and hazardous articles is a safe guide in selecting and designing a package. The cost, volume of production, and the physical and chemical properties of each material will be the factors to determine whether or not to use a tray, box, drum or other container—but do not forget the drop test.

The manufacturer can learn a great deal from this test which will give him the best possible guide toward the ideal package. The cost of the material and the volume of traffic will, of course, limit the amount of money that can be spent on a container. But with ingenuity, patience in surveying the packages of competitors, and with close cooperation with package manufacturers and the manufacturers of materials of construction and of packaging machinery, each special problem can be solved in a way to repay many times the effort expended.

C. B. Dickey

Paint and Varnish Division,
Pittsburgh Plate Glass Co.,
Milwaukee, Wis.

Question: As a shipper of chemicals have you any suggestions for the simplification or clarification of the I.C.C. Regulations for the Transportation of Explosives and Other Dangerous Articles?

Rock Wool Manufacture

To the Editor of Chem. & Met.:

Sir—Your editorial in *Chem. & Met.* for March, 1935, entitled "Rock Wool: A Potential Industry" was very interesting, especially from our viewpoint as suppliers of rock wool products and other insulating materials.

Without wishing to question your suggestion that process industries looking for new products consider the possibilities of rock wool manufacture, I should like to add a few words of caution based on our experience, that a manufacturer contemplating rock wool manufacture would do well to include in his calculation.

1. In addition to rock, slag of proper chemical constitution is also used in mineral wool manufacture. Sometimes a combination of material from these two sources produces a satisfactory wool at lowest cost provided the raw material costs are right. At any rate, the results should be carefully worked out in advance on a semiplant scale before an investment is undertaken.

2. Consideration should be given to proximity of the market for freight rates on the product are high. Also the market should be well assured, for the industry is already glutted with excess manufacturing capacity, some of which is in the hands of powerful competing well established interests.

3. To date, the bulk of wool manufacture is not disposed of as such but must be further fabricated into cements, blocks, pipe covering, batting, etc., in order to find a ready market at satisfactory prices. This would greatly increase the investment; consequently would also increase the necessity for an assured market and for a sales outlet well established with the trade.

4. Mineral wool, in the loose form, is at present enjoying a brisk market in house insulation, but cognizance should be taken of several factors in this outlet. Here competition must be met not only from established manufacturers of this product but also from some competing forms of insulation of high quality and good price, such as expanded vermiculite, wool batting, and certain vegetable fiber products. One's outlets must be experienced in the problems of application, and, where special devices are required in applying the product, may also have to be assisted in obtaining them.

If these factors so briefly covered here are given careful consideration beforehand and are provided for, rock wool production may serve as a suitable adjunct to certain process industries.

Wm. S. Bryant

Doster, Dressel & Bryant,
Chicago, Ill.

To the Editor of Chem. & Met.:

Sir—In connection with the efforts to rescue the title of *Engineer* from the indignities suffered by its application to "experts" in practically all professions, high or low, the readers of *Chem. & Met.* may render a valuable service to their profession by reporting misuse of this title in the State of New York to Mr. James O. Hoyle, Room 870, 80 Centre Street, New York, N. Y., or to State Educational Department, Professional Licensure Division, Albany, N. Y., or both. The work of stamping out this menace to professional dignity cannot be successfully accomplished by a small body of men. It requires the assistance of the entire profession, with the individual members acting as scouts to discover illegal users of the title.

John H. Kelly

718 West 178th Street,
New York, N. Y.

Readers' VIEWS AND COMMENTS

Corn Starch Adhesives vs. Sodium Silicate

To the Editor of Chem. & Met.:

Sir—In reference to the use of adhesives in the paper conversion industries, Mr. Russell Morehouse, in his paper presented at the recent meeting of T.A.P.P.I., has failed to go sufficiently far in his discussion.

At the outset, flour pastes and various other similar preparations were used in the laminating industry when the sheets were laid up by hand; the machinery for these operations of solid fiber and corrugated lamination were crude. Silicates then came into use, and for the last 25 years, until about 1929, they held full sway as the almost universally used adhesive for both corrugated and solid fiber lamination.

However, with the advent of kraft paper and especially the fourdrinier kraft paper made in the South, a new and different problem presented itself. Almost coincidental with the widespread use of southern kraft came the bulking of the filler stock, and the rough dry finished sheets which had as their goal a lighter laminated sheet of paper. It was very difficult to stick fourdrinier kraft with silicate of soda; with silicate used as adhesive much trouble was also experienced with discoloration of the kraft, with "striking through" of the silicate, and fading of the print on the boxes made from the laminated board.

In cooperation with Hinde & Dauch Paper Co. the writer in 1929 developed a satisfactory adhesive from corn starch. Two years later this product was to be known in the industry as Staybind and has largely replaced silicate of soda for solid fiber lamination. Very little has been done toward the application of starch adhesives to corrugated board, but in solid fiber starch adhesives have largely replaced silicate of soda because of a great many factors, among which are:

A lighter sheet of board is produced; increased Mullen test; no danger from discoloration due to low alkalinity of starch adhesives; no hazard to machine operators; machines can be run about 50 per cent higher speed; lower machine waste; longer life to slitters. Where laminated board is to be printed it is not necessary to use alkali proof inks, and the printing retains more gloss and "snap" than when high alkali adhesives are used. Laminated board, when used for shipping containers, can be creased more sharply and deeper without injury to the liner, than when mineral adhesives are employed. Starch adhesives of proper type are applicable to all kinds of papers, including fourdrinier kraft; and they are being used for fabrication of caddy board, and lined stock as well as for the lamination of container board and wall board, panel stock, and cigar box board. When properly applied starch adhesives produce practically no warpage in the paper and add less water to the sheet than silicate of soda, although the starch adhesives usually carry about 75 to 80 per cent of water compared with about 60 per cent for silicate of soda. This is because only about half as much of the liquid starch adhesive is required as would be necessary in the use of silicate of soda.

Because starch adhesives are more viscous than silicate it has been the experience of the writer that the rolls in the pasting machine which apply the film of adhesive to the sheet of board must have slightly more crown than when a less viscous adhesive is used.

H. D. King
Industrial Chemist and Engineer,
7258 S. Artesian Ave.,
Chicago, Ill.

To the Editor of Chem. & Met.:

Sir—Mr. King has correctly stated that silicate of soda for many years has been the standard adhesive for laminating board for fiber boxes and that the introduction of new materials and more porous papers has required adjustment of adhesive technique. This adjustment would have been required without regard for the type of adhesive which was in use.

A great advantage which silicate of soda gives to the box board industry is the accurate control made possible by an adhesive ready to use. Silicate manufacturers have hesitated to advise their customers to introduce a mixing operation in their plants where the adhesive could not be standardized and controlled as accurately as that to which they have been accustomed.

The characteristics of silicate of soda favor the use of this material in high-speed combining operations. The writer has observed satisfactory board made at a speed of 400 ft. per min. using silicate of soda as the adhesive.

Adhesive mixtures of silicate and clay are also usefully applied in the box board industry. It has been shown that mixtures of silicate and clay made cold will operate at the highest speeds which the industry has thus far used, that they will satisfactorily hold all the usual kinds of paper, that the waste incidental to operation is not greater than the best practice with starch, and that the board leaves the machine in a firmer condition than when starch is used. With the silicate-clay mixtures there is no occasion to recrown the rolls or otherwise change the laminating machine.

In order to obtain the economical adhesive spreads of which Mr. King speaks, it is necessary to have a paper of relatively smooth finish. Such a paper also favorably affects the spread of silicate adhesives.

The theoretical difference in the weight of the board is not a matter of importance in good practice as the total weight of solids contributed by the adhesive is not greater than 4 lb. per 1,000 sq.ft. of glue line.

The claim of increased Mullen test is peculiarly difficult to evaluate. This test is affected by many variables other than the adhesive and the experience of the writer does not indicate that good practice with silicate of soda needs defending on this account.

Good practice with silicate of soda or silicate-clay mixtures creates no staining problems with the paper currently used in the industry.

Neither starch nor silicate of soda is hazardous from a practical point of view. Silicate in the eye is painful but we have no record of permanent injury. Many articles of common use are unsuited for introduction into the eye.

The silicate-clay mixtures used in the container industry have less water per unit of weight or volume than any other aqueous adhesive. They yield stiff flat boards which stand scoring well; they can be used at maximum speeds and minimum waste with all the ordinary papers. The cost of silicate-clay mixtures is fundamentally low and free from price fluctuations due to varying agricultural conditions.

Russell Morehouse
Engineering Dept.,
Philadelphia Quartz Co.,
Philadelphia, Pa.

Chemical Engineer's BOOKSHELF

Motor Fuels Abroad

PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION, Vol. I. By *Alfred W. Nash* and *Donald L. Howes*. Published by John Wiley & Sons, Inc., New York. 538 pages. Price, $8.

Reviewed by *W. L. Nelson*

THE AUTHORS present a comprehensive discussion of all phases of the use and manufacture of motor fuels. Volume I discusses distillation, cracking, natural gasoline, refining, hydrogenation and distribution; and the use of benzol, alcohol and synthetic fuels. Volume II is in the press and it will review the relation between the physical properties of motor fuels and their performance in the modern automotive engine. Although the subject is one that has been treated by several other authors, it continues to be of interest because of the rapid developments in motor fuel technology. The numerous specifications of motor fuel properties and the extensive index of current literature, constitute a valuable record of developments during the last decade.

The dependence of European countries on other fuels than gasoline is forcefully emphasized by the extensive discussion of benzol, alcohol and other fuels; and of the processes of hydrogenation, shale distillation, destructive distillation and polymerization. At the present time these fuels and processes are not used to any extent in the United States but with the present rapid exploitation of petroleum reserves, the United States may at any time be confronted with the same needs as those of European countries.

The chapter on the refining of motor fuels is particularly noteworthy. This extensive subject is organized in a clear and comprehensive manner. The chapter on hydrogenation is also valuable because so few complete and organized discussions of hydrogenation are available. The complete indexing of patents and current literature should be of value to all refiners.

The modern trend of engine manufacture and the constantly increasing demands that must be met by motor fuel manufacturers are forcefully evident. High speed internal combustion engines are a necessity in our modern civilization and year by year the production of an adequate supply of motor fuel will become increasingly difficult.

The book is intended mainly for chemists and students but it should be valuable to engineers in the oil industry. It is one of the most extensive surveys of motor fuel production that has been published.

Spectroscopy

METALLURGICAL SPECTRUM ANALYSIS. By *Welton J. Crook*. Published by Stanford University Press, California. 82 pages. Price, $12.50.

Reviewed by *H. B. Vincent*

THIS is a very welcome addition to the literature in this field. The tables published in 1933 have proved to be the most convenient reference available for the location of lines in the spectra of ferric alloys and the determination of possible interference with lines chosen for analysis by lines from other elements which may be present. The new additions to the tables increase their utility and it is hoped that the author will presently extend their range to shorter wavelengths so that more lines of such elements as silicon may be included. The charts are well arranged and if used as described in the text should provide rapid qualitative analysis.

From the standpoint of quantitative analysis it is thought that the choice of equipment is open to some question. The desirability of a linear dispersion scale for the rapid location of lines is obvious, but where considerable work is done with a single pair of lines the prism spectrograph, which does not produce ghosts and higher order spectra, appears preferable.

Vigorous exception is taken to the author's statements on pages 3 and 24 regarding the limitations of quantitative spectrographic analysis. Successful work on nickel-barium alloys has been reported from this laboratory, (Duffendack, Wolfe and Smith, *Ind. Eng. Chem.*, Vol. 5, page 226, July 15, 1933). The method described has been in continuous use and has proved completely successful. More recent work on ferric alloys will be reported in the near future. The spectrograph has been shown to be capable of chemical analysis for routine control of iron composition in one of Michigan's largest foundries. Costs need not be excessive and the fact that results are available almost immediately (less than one hour) assists greatly in the maintenance of a uniform output.

The clearness of the exposition in the text is appreciated. It is easy to follow and complete in detail. The reader is never in any doubt as to what the author means.

Lacquer Data

NITROCELLULOSE ESTER LACQUERS. By *Fritz Zimmer*. Translated from the German by H. K. Cameron. D. Van Nostrand Co., New York. 246 pages. Price, $7.

Reviewed by *James A. Lee*

DURING the years following the War the nitrocellulose ester lacquers have gained much prominence, particularly in the automotive industry and in furniture manufacture. The interest in their production has manifested itself in much fruitful research and development, and a rapidly increasing field of application.

The present volume, which covers an extensive field in a condensed form, is divided into three main sections; properties of raw materials used in the manufacture of nitrocellulose ester lacquers; early and modern nitrocellulose lacquers; and methods of application and fields of use. The book is written principally as an aid to the chemist and the plant operator, to assist them in the solution of their practical problems, and the establishing of chemical formulas and extensive treatment of theories have therefore been omitted. It contains descriptions of modern manufacturing and spraying plants in the United States as well as in Germany, and a wealth of tabulated data and physical and chemical constants on raw materials. The author's wide experience in the field has enabled him to give a clear presentation of this important branch of applied chemistry.

Organic Electronics

TAUTOMERISM. By *John William Baker*. Published by D. Van Nostrand Co., Inc., New York. 332 pages. Price, $9.

Reviewed by *P. H. Groggins*

THE BOOK is essentially an electronic interpretation of tautomerism, with special emphasis being given to C. K. Ingold's concepts of such reversible isomeric changes. Consideration is given first to the relationship of tautomerism and additive reactions and the development of the modern theory of tautomeric change. This is followed by a detailed discussion of cationotropic and anionotropic systems. Other chapters relate to valency tautomerism and pinacolic electron displacement.

Despite Professor Ingold's more readable appendix on the significance of tautomerism to organic reactions, it is doubtful whether the book will make a

wide appeal to workers in the field of organic chemistry. Because of cumbersome terminology and symbols, the text has to be studied rather than read. The material is not presented in a form that lends itself to simple adaptation or application to practical problems in organic synthesis. For example, it would be useful in the discussion of the reversible additive reactions of tautomeric change (page 213) to have statistical and theoretical information relating to the physical and chemical factors that govern the rates of such addition and intramolecular rearrangement. In other words, the text is largely an electronic explanation of tautomeric change, rather than a guide which teaches the control of such reversible reactions.

The book represents a laborious and painstaking task, and it should be of value to students interested in the electronic theory as it relates to organic reactions.

Gas Technology

AMERICAN GAS PRACTICE, VOL. II, DISTRIBUTION AND UTILIZATION OF CITY GAS. By *Jerome J. Morgan*. Published by the author, Jerome J. Morgan, Maplewood, N. J. 1,031 pages. Price, $8.

Reviewed by *R. S. McBride*

NOT ONLY the gas industry, but also chemical engineers interested in gas handling technique, will welcome this thoroughly revised and largely amplified volume. With its companion work on production of manufactured gas issued three years ago, it constitutes the best available descriptive work on American practice.

Dr. Morgan has had the cooperation and critical assistance of a distinguished and able committee of gas engineers representing American Gas Association. Thus the reliability of the work is given extra assurance and its general acceptance as authoritative will not be questioned.

The volume is descriptive in character with a generous number of well chosen illustrations. Prepared partly as a college text, it is pedagogically excellent. But it does not suffer in this respect as a reference work because it is splendidly indexed and well phrased to give the user those details of engineering practice which occasion use of such a volume most frequently.

In its purpose and scope, the book differs markedly from "Gas Engineers' Handbook," issued last summer. Although covering some of the same types of industrial activity, the present work is descriptive and generally informative, rather than of prime value to secure engineering data such as one wishes and obtains from the Handbook. Thus a welcome companion service is afforded to users.

Chemistry Handbook

HANDBOOK OF CHEMISTRY. Edited by *N. A. Lange*. Published by Handbook Publishers, Inc., Sandusky, Ohio. 1,545 pages. Price, $6.

Reviewed by *Paul D. V. Manning*

THIS IS more than a handbook of tables—it is an interesting book on chemistry, with well selected material, well arranged and well edited. It is a compact book of better size than the usual handbook, printed on thin, opaque paper with an easily read type.

The chemist will rejoice in the completeness of its tables of physical constants and other tables relating to his work. The engineer will appreciate the tables giving data in both metric and English units.

There are sections on foods, vitamins, milk. There is a complete section of mathematical tables including integrals. This book cannot, of course, replace Perry's handbook, but with both, the chemical engineer will be prepared with all data which can be easily published. This new handbook is a valued addition to the tools of any chemist.

TESTING PRECIOUS METALS. Second Edition. By *C. M. Hoke*. Published by The Jewelers Technical Advice Co., New York. 60 pages. Price, $1.

A POPULARLY WRITTEN manual for those buying, selling, and working old gold, silver and platinum metals. It discusses in detail the common methods for testing these metals, in pure or alloyed form, and the important points to be observed by those dealing with previous methods. The author is well-known among chemists for her contributions on compressed gases.

Flammable Liquids

FIRE-HAZARD PROPERTIES OF CERTAIN FLAMMABLE LIQUIDS, GASES AND VOLATILE SOLIDS. Compiled by Committee on Flammable Liquids of National Fire Protection Assn. Published by N.F.P.A., 60 Batterymarch St., Boston, Mass.

A VERY VALUABLE reference booklet showing flash point, ignition temperature, range of explosive limits of vapor in air, vapor density, and other pertinent information.

GERMAN-ENGLISH CHEMICAL TERMINOLOGY. By *Alexander King* and *Hans Fromherz*. D. Van Nostrand Co., Inc., New York. 324 pages. Price, $5.

IN THIS introduction to chemistry, written both in English and German, the authors have given exact definitions of the terms in common use in the science by presenting them in a suitable context, thus making the meaning clearer than is possible in an ordinary dictionary. Each expression occurring for the first time is written in italics in both the German and the English text, and all words thus designated are compiled in an index at the end of the book, containing more than 4,000 expressions. The book should be very valuable to students, research workers, and in general to all readers of chemical literature.

ROCK WOOL FROM ILLINOIS MINERAL RESOURCES. Bulletin No. 61 of the State Geological Survey, Urbana, Illinois. 262 pages.

A RECENT investigation has revealed that suitable raw materials for rock wool are found in six major areas of the state of Illinois, all close to lines of transportation and large markets, and also in fifteen other areas of lesser importance. The report also gives much new information obtained by laboratory investigations on the range of chemical compositions for the production of rock wool, and on the factors which determine the texture, color, and other qualities of satisfactory rock wool.

FUNDAMENTALS OF DAIRY SCIENCE. Second Edition. American Chemical Society Monograph Series. By associates of *Lore A. Rogers*. Published by Reinhold Publishing Corp., New York. 615 pages. Price, $6.

RAPID ADVANCES in research and increased knowledge of such subjects as vitamins, pigments, and sterilization have necessitated a second edition of this volume, the first edition of which appeared in 1928. Practically all chapters have been revised and enlarged, a total of almost 200 pages having been added.

BRITISH CHEMICALS AND THEIR MANUFACTURERS. Published by the Association of British Chemical Manufacturers, London. 459 pages.

A DIRECTORY of the members of the Association of British Chemical Manufacturers, with a classified list of products, printed in English, French, German, Italian, Portuguese, and Spanish, and available gratis, upon request to the Association, to all genuine purchasers of chemicals.

X-RAYS IN THEORY AND EXPERIMENT. By *Arthur H. Compton* and *Samuel K. Allison*. D. Van Nostrand Co., Inc., New York. 828 pages. Price, $7.50.

A COMPLETE TREATMENT of x-rays, covering both the fundamental principles and the study of crystal structure, and explaining all facts fully and clearly without difficult mathematical calculations. Every branch of the subject is developed simply from its basic principles, and in every case quantitative expressions are deduced

which can be tested experimentally. This combination of theory and experimentation makes the book valuable to every worker in the field. Several thousand experiments have been summarized in convenient tables for easy reference, and hundreds of figures illustrate the results in graphical form.

BRITISH PLASTICS YEAR BOOK FOR 1935. Published by The Plastics Press Ltd., Ludgate Hill, London. 718 pages. Price, 15 shillings.

THE 1935 edition of the Year Book has been enlarged and certain changes have been made. The editorial section contains an entirely new list of articles covering such subjects as the plasticity of molding materials, resins as colloids, laminated plastics for architectural use, cast phenolic plastics in Germany and the United States, and the manufacture of cellulose acetate. The section on names and addresses of those interested in the plastic industry has been modified, and shortened. The list of trade names accompanied by certain information about each one has been brought up-to-date. The sections containing lists of manufacturers and suppliers of raw materials and equipment used for the production of plastics have been enlarged to include more names under each material and piece of equipment. Additional tables of physical data useful to the engineer working with plastics have been added to the new volume.

INTERNATIONAL ACETYLENE ASSOCIATION PROCEEDINGS. Published by the International Acetylene Association, 30 East 42d St., New York. 201 pages.

PROCEEDINGS of the Thirty-Third Annual Convention held in Philadelphia, Nov. 16-18, 1932.

BLUE BOOK OF THE GAS INDUSTRY. Compiled and published by *Western Gas*, Los Angeles, California, 1934 edition. 176 pages. Price $2.50.

A PERSONNEL directory of gas company officials and a "buyers' guide" indicating the principal manufacturers of commodities and equipment used in gas manufacture and distribution.

BULLETIN OF THE NATIONAL RESEARCH COUNCIL No. 95. Third Edition. Compiled by *Callie Hull* and *Clarence J. West*. 162 pages. Price, $1.

INFORMATION concerning funds available at about 500 colleges, universities, societies, and foundations in the United States for the encouragement and support of research in the form of medals, prizes, grants, and institutional funds, outside of fellowships, scholarships and federal funds. The entries are arranged alphabetically, with an index to names and classes of funds and subjects covered.

Butane Handbook

HANDBOOK OF BUTANE-PROPANE GASES, Second Edition. Edited by *George H. Finley*. Published by *Western Gas*, Los Angeles, Calif. 375 pages. Price, $5.

TWO YEARS of added experience and the broadening of the industry are reflected in this enlarged second edition. Scientific sections give very fully physical properties, testing methods, and other pertinent laboratory information. Other chapters describe the technique of manufacture of liquefied petroleum gases and their transportation and storage. Other chapters deal with the use of these hydrocarbon gases with manufactured gas, for separate petroleum-gas service, in internal combustion engines, as industrial fuels, and through distributing systems or in bottled form for general service.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Skin Hazards in American Industry, by Dr. Louis Schwartz and others. Public Health Service Bulletin 215; 10 cents.

Effect of Various Amounts of Sodium Fluoride on the Teeth of White Rats, by H. Trendley Dean and others. Public Health Service Reprint No. 1647; 5 cents.

The Potential Problems of Industrial Hygiene in a Typical Industrial Area in the United States. Public Health Service Bulletin 216; 5 cents.

Methods for Determining the Hydrogen-Ion Concentration of Soils, by E. F. Snyder. Department of Agriculture Circular 56, Revised January 1935; 5 cents.

Conservation of Wastes From the Small-Scale Slaughter of Meat Animals, by G. P. Walton and R. F. Gardiner. Department of Agriculture Circular 63, Revised December, 1934; 5 cents. Discusses method of disposal of perishable refuse whereby the valuable nitrogen and phosphoric acid might be conserved for use as fertilizer.

Casein Manufacturing by New Methods Cuts Costs, Improves Product, by R. W. Bell. Department of Agriculture, Separate from Yearbook of Agriculture, 1934, No. 1438.

Naval Stores Handbook. Department of Agriculture Miscellaneous Publication 209; 20 cents. Deals with the production of pine gum or oleoresin.

Cotton and Cottonseed, by Rachel P. Lane and Emily L. Day. Department of Agriculture Miscellaneous Publication 203; 15 cents. A list of the publications of the United States Dept. of Agriculture on these subjects, including early reports of the United States Patent Office.

Oil Retention, Oil-Emulsifier Ratio, and Oil-Water Ratio as Affecting the Insecticidal Efficiency of Emulsions, by A. W. Cressman and L. H. Dawsey. Department of Agriculture, reprint from Journal of Agricultural Research, Vol. 49, No. 1, July 1, 1934; 5 cents.

Lime-Sulphur Concentrate, Preparation, Uses, and Designs for Plants, by E. H. Siegler and A. M. Daniels. Department of Agriculture Farmers' Bulletin 1285; 5 cents.

1934 Report on New York Imports of Chemicals and Medicinals Not Specially Provided for in the Tariff Act of 1930 (Paragraph 5). Tariff Commission unnumbered document; mimeographed.

A Graphic Analysis of the International Trade of the United States in 1932. Tariff Commission, Miscellaneous Series; $2.25. Contains charts illustrating imports and exports and other phases of international trade.

Production and Distribution of Salt in the United States by Primary Producers. Tariff Commission unnumbered document; mimeographed.

Survey of Fuel Consumption at Refineries in 1933, by G. R. Hopkins. Bureau of Mines Report of Investigations 3270; mimeographed.

Effect of Soot on Heat Transmission in Small Boilers, by P. Nicholls and C. E. Augustine. Bureau of Mines Report of Investigations 3272; mimeographed. Discloses methods of equipment testing.

Mineral Physics Studies, by R. S. Dean and others. Bureau of Mines Report of Investigations 3268; mimeographed. Contains chapters on applied mineral physics; explosive shattering as a possible economical method of ore preparation; electrical properties of mineral aggregates, natural and artificial aggregates of crystallized lead sulphide; apparatus for determining magnetic constants of mineral powders; magnetization curves for magnetite powders; coercive force of magnetite powders; magnetic properties of mineral powders and their significance; practical aspects of alternating-current magnetic separation.

Lead and Zinc Mining and Milling in the United States, Current Practices and Costs. Bureau of Mines Bulletin 381; 5 cents.

A Report on Petroleum Development and Production, by H. C. Miller and Ben E. Lindsley and "A Report on Effect of Technologic Factors on Supply of and Demand for Petroleum Products," by A. J. Kramer. Portions of Part 2 of the hearings before a subcommittee of the House Committee on Interstate and Foreign Commerce, 73rd Congress, on H. Res. 441.

Soil Corrosion. Bureau of Standards Letter Circulars 433 and 434; mimeographed.

Psychrometric Charts for High and Low Pressures, by Donald B. Brooks. Bureau of Standards Miscellaneous Publication M-146; 5 cents.

Commercial Lists. Sources of supply of commodities covered by Federal Specifications, Bureau of Standards Letter Circular 256a with Supplements Nos. 1 and 2 and Amendment to Supplement No. 2; mimeographed. Sources of Supply of Commodities Covered by Commercial Standards, Letter Circular 277a; mimeographed.

Mineral Production Statistics for 1934—preliminary mimeographed statements from Bureau of Mines on: Zinc; aluminum; asbestos; sulphur; natural sodium compounds; molybdenum; aluminum salts; lead; Indiana Oolitic limestone; magnesite; bauxite; potash; value of mineral products of the U. S. 1931-1933, by states.

Unemployment Insurance and Reserves in the United States, by Laura A. Thompson. Bureau of Labor Statistics Bulletin 611; 10 cents. A selected list of recent references.

Inventions and Patents. Miscellaneous Army Regulations No. 850-50, Dec. 31, 1934; 5 cents.

Grease, Lubricating. Federal specifications on Grease, Lubricating, Driving-Journal, VV-G-661; Grease, Lubricating, Graphite, VV.-G-671; Grease, Lubricating, Mineral, VV-G-681; 5 cents each.

Biennial Census of Manufactures, 1931. Bureau of the Census; $1.75, 1292 pages (Buckram). Presents in one volume statistics compiled for 1931 with comparative figures for earlier years.

Production Statistics From 1933 Census of Manufactures—printed pamphlets on: The Rubber Industries; Ammunition and Related Products, Explosives, Firearms; Confectionery, Chocolate and Cocoa Products, Chewing Gum; Silk and Rayon Goods, Rayon and Allied Products; 5 cents each.

Your Plant NOTEBOOK

Heat of Dilution of Sulphuric Acid

By A. P. Haught
Newell, Pa.

BY MEANS OF the two curves given herewith it is possible to obtain with sufficient accuracy for most purposes the heats of dilution of sulphuric acid solutions, easily and without any of the laborious calculations ordinarily required. The curves are based on Thomsen's formula (from Thomsen's Thermo-Chemistry) in which

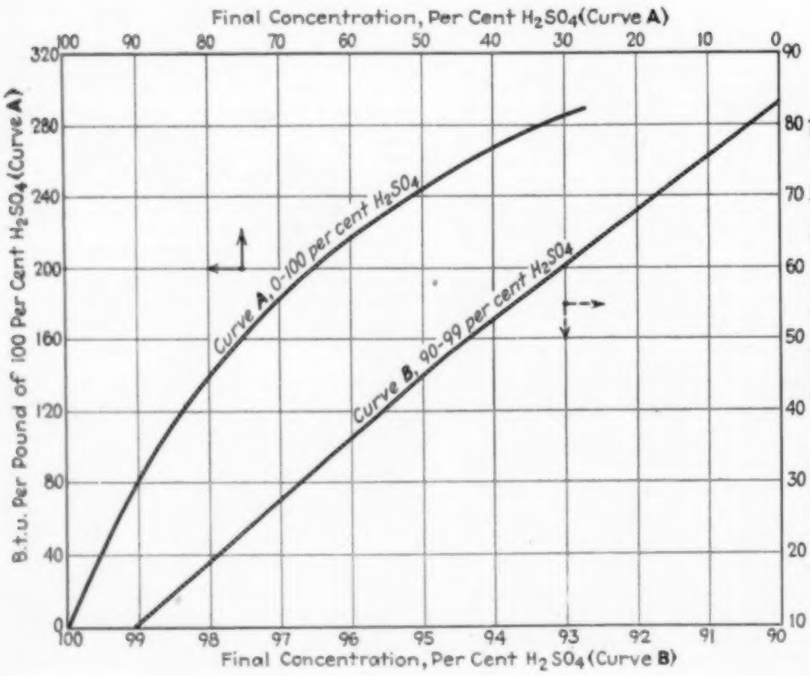
$$H = \frac{17{,}860n}{1.798 + n}$$

where H = heat units per mol of H_2SO_4 and n = mols of water added per mol of H_2SO_4.

In the equation, if molecular weights are expressed in grams, H will be in calories, while if pound-mols are used, the results will be in C.h.u. The curves have been calculated to give heats of dilution for various concentrations in B.t.u. If the result is desired in C.h.u., divide by 1.8.

The curves, it will be noted, give heat of dilution for the case where 100 per cent acid is diluted. Dilution of other concentrations can be handled with equal ease by taking the difference between the ordinates for the final and starting concentrations.

Chart for determining heats of dilution of sulphuric acid

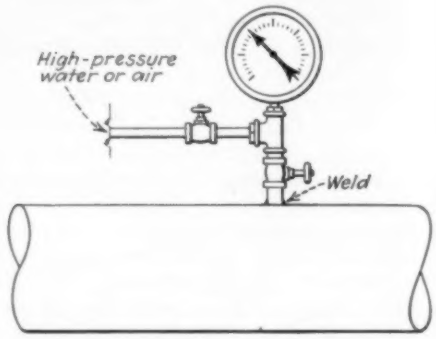


Pressure Gage Hook-Up for High-Consistency Fluids

By J. H. Wilcox
Longview Fibre Co.
Longview, Wash.

IN MANY industrial plants the measurement of the pressure of fluids of high consistency presents a problem, owing to the material plugging the pressure gage or the line to it. An arrangement as shown in the illustration will eliminate any plugging trouble that might be encountered.

The pressure gage is mounted on a ½-in tee which is connected to the line in question through a ½-in. valve. Air

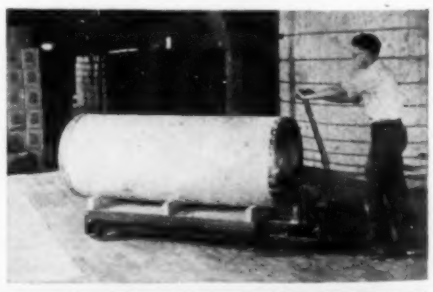


Pressure gage hook-up for use with high-consistency fluids

or water at a higher pressure is supplied to the tee through a ¼-in. valve. When a pressure reading is required, the ¼-in. valve is cracked open and then the ½-in. valve to the main line is opened. This causes a flow of air or water out into the line and prevents any of the dense fluid from entering the gage or the line to it.

Method and Equipment for Handling Drums Filled With Liquid Gases

These illustrations show how drums filled with chlorine are handled in the plant of the Hypochlorite Co., of Buffalo, N. Y. The upper view shows a 1-ton container being moved by a lift truck. It is set on a skid platform with a cradle to hold the cylindrical form of the drum. The lower view shows a line of drums arranged for the withdrawal of the chlorine. As will be seen they are connected with piping.—Contributed by Francis A. Westbrook, Center Conway, N. H.



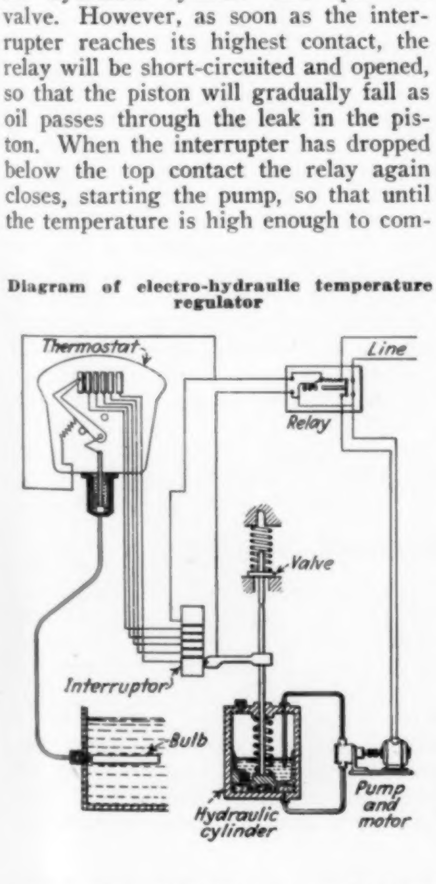
News of EQUIPMENT

Electro-Hydraulic Temperature Regulator

A novel hydraulic device is employed to obtain throttling valve action in a new temperature regulator developed by the Wilbin Instrument Corp., 40 East 34th St., New York City. This is best explained in conjunction with the accompanying sketch. The thermostat uses a fluid-filled temperature-sensitive system to position a sliding contact on a contact block with five contacts, two on each side of the control point. The temperature range over the five contacts is adjustable, but can be made as small as 1 deg. F.

When the system is cold, no contact in the thermostat will be made and the relay will start the pump motor so as to build up pressure under the piston in the hydraulic cylinder and open the valve. However, as soon as the interrupter reaches its highest contact, the relay will be short-circuited and opened, so that the piston will gradually fall as oil passes through the leak in the piston. When the interrupter has dropped below the top contact the relay again closes, starting the pump, so that until the temperature is high enough to complete the first thermostat contact, the valve will oscillate or throttle at a point near full open.

Diagram of electro-hydraulic temperature regulator



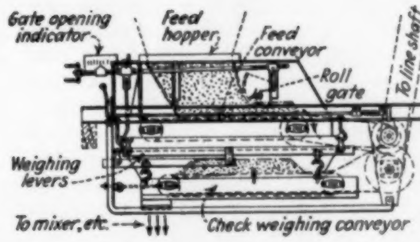
As soon as the first thermostat contact is made the highest interrupter contact is connected to the next one below, so that the valve will then oscillate at the next lower interrupter contact position. Thus the valve will find a position that corresponds as closely as possible to the correct position for the desired temperature and will hold this position until a shift in demand forces it to oscillate at a slightly different point.

Self-Checking Weigher

An automatic weighing and feeding device, known as the Conveyometer, and so designed that it constantly checks the results of its own operation, has recently been put on the market by the Richardson Scale Co., Clifton, N. J. The new machine is intended both for use singly in delivering a succession of equal loads to any piece of equipment or for use in batteries of two or more for proportioning the several ingredients entering into a batch.

The machine consists of a feed hopper, discharge from which is controlled by a manually adjustable gate, placed over a feed or measuring conveyor which discharges to a check-weighing conveyor. In operation the gate is set to deliver a proper thickness of material of known density to the feed conveyor. The latter moves forward intermittently, thus depositing a discontinuous load upon the continuously operating check-weighing conveyor. This second conveyor is supported on a scale system and as each load is received the scale, by means of a tell-tale device, indicates whether the load is light, correct or heavy. Should the weight not be correct the operator is enabled immediately to reset the feed gate for proper delivery.

A speed-changing device is provided whereby the length of travel of the feed conveyor per cycle can be set either at a low figure or at one three times as great. In combination with the considerable



Elevation of new Conveyometer

adjustment of the feed gate the machine delivery rate can be varied over a wide range. Other features include the use of dust-proof construction, grease-packed ball bearings and special, trouble-free rubber belting. Sizes range from 600 to 1,200 cu.ft. per hour maximum discharge capacity.

Equipment Briefs

For the efficient heating of furnaces, ovens, dryers, lehrs and preheaters, the Philadelphia Drying Machinery Co., 3351 Stokeley St., Philadelphia, Pa., has developed a new low-pressure oil burner, designed to give efficient combustion over a wide range of capacities and with various grades of fuel. High efficiency is attained by the use of a design which governs the regulation and also the distribution, velocity and turbulence of the primary and secondary air as it comes in contact with the oil. Primary air and oil are mixed in a venturi. Secondary air passes around the Venturi and meets the primary mixture near the nose of the burner. An adjustment is provided for variable capacity. Nine sizes, ranging from $\frac{3}{4}$ to 6 in., are available for pressures from 8 to 32 oz. of air.

Byron Jackson Co., Berkeley, Calif., has announced a new pump known as the "Hydropress" which is of the centrifugal type, for pressures up to 2,800 lb. The number of stages used may vary from 4 to 54 depending on conditions. Capacities are available from 10 to 250 g.p.m. in sizes from 8 to 15 in.

A recent announcement of the Bristol Co., Waterbury, Conn., describes the new Model 478 pyrometer controller which is said to possess "degree-splitting" characteristics. The new controller employs closed mercury contacts, requires no relays and features accessibility of all parts.

The Sarco Co., 183 Madison Ave., New York City, has developed the new No. 9-200 thermostatic steam trap for pressures up to 200 lb. per square inch. The trap is built with silver solder but this solder is used only to act as a seal and does not take up stresses. A shield outside the thermostatic element protects it against abrasive action of steam and water, and acts also as a stop to prevent over-expansion should the element be removed when it is hot. Stainless steel is used for both head and seat.

Unequal ply stresses set up in the wall

of hose by longitudinal and lateral tension incident to operation are said to be compensated and made equal in a new air hose announced by the Manhattan Rubber Mfg. Division, Raybestos-Manhattan, Inc., Passaic, N. J. This result is attained by the use of two strength members, a braided cord member for longitudinal stresses and a spiraled strength member for expansion and lateral stresses, both welded in tough, age-resisting rubber.

Built in sizes and types for any water-gas machine, a new three-way backrun valve has been announced by the Semet-Solvay Engineering Corp., 40 Rector St., New York City. An access door is provided the full height of the box. Seating of the disks has been improved; the disk seats themselves are removable. The two bearings are both large and are exposed, to be cooled by radiation.

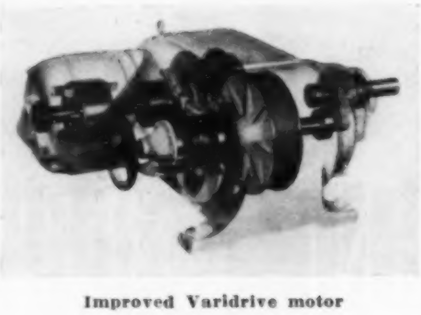
Baker Industrial Truck Division, Baker-Raulang Co., Cleveland, Ohio, has announced a new mobile scoop truck of 2500 lb. capacity. This is designated as Type HFG and is stated to be suitable for all sorts of loose material. The scoop is tipped backward for carrying and may be elevated several feet for discharging. The truck is available for operation either with a storage-battery or a gas-electric power plant.

Ability to increase the scale range of its photoelectric light meter ten times has been announced by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This increase is accomplished through the addition of a translucent screen which may be clamped over the photocell disk.

Harnischfeger Corp., West National Ave., Milwaukee, Wis., has announced an entirely new line of convertible squirrel-cage and slip-ring induction motors. These motors are readily converted from open type to fan-cooled, splashproof or totally-inclosed construction through employing interchangeability in the design of the four above-mentioned types.

Technical Products Co., Pittsburgh (15), Pa., has announced a new quick-setting acidproof cement known as Sauer-Eisen No. 21. This cement hardens through chemical action within 36 hours. In use the cement requires only to be mixed with water to a creamy consistency. In addition to use with acids, the cement is recommended for resistance to water, fumes and many solvents.

A new lance-type pyrometer, known as the Hold-Heet, has been announced by the Russell Electric Co., 347 W. Huron St., Chicago, Ill. This is a portable hand instrument, suitable for checking temperatures in all applications where wall-type pyrometers are used. It is available at low cost in various ranges from temperatures of 60-800 deg. F. to 50-2,500 deg. F.



Improved Varidrive motor

Varidrive Developments

U. S. Electrical Mfg. Co., 1529 South Western Ave., Chicago, Ill., has effected a number of improvements in its Varidrive motor, as indicated in the accompanying phantom view. A new lever arm construction has been developed for the larger horsepower ratings and the formerly separate units, consisting of constant-speed motor, variable-speed device and gear case, have now been built into a single compact unit.

Improved Chilling Machine

Carbondale Machine Corp., Harrison, N. J., has announced what are described as important improvements in its chilling machines for use in petroleum refineries. The chiller is a double-pipe heat exchanger in the inner pipe of which the liquid to be cooled flows. In order to prevent deposits of constituents which would adversely affect heat exchange, a flexible ribbon conveyor of spiral type rotates within the inner pipe, preventing any adhesion of solids to the wall. This combination cleaning and agitating effect is said greatly to increase heat transfer. The conveyor drive has also been improved, with extra deep stuffing boxes through which the drive shafts extend and through the use of a heavy chain drive.

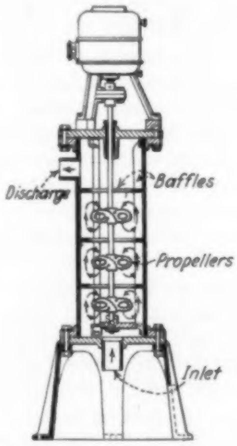
New Gyratory Screen

What is described as a unique type of screening action is obtained in a new all-purpose gyratory screen manufactured by Beardsley & Piper Co., 2541 North Keeler Ave., Chicago, Ill. This screen operates with a combination of circular, vertical, oblique and forward and backward movements. It is said to be of high capacity per square foot and to impart no vibration to the adjacent superstructure. Screen surfaces are easily and quickly changed, lubrication is simple and the operating mechanism is sealed against dust. Sizes are available to 70 tons capacity, and over.

Novel gyratory screen

Continuous Emulsifier

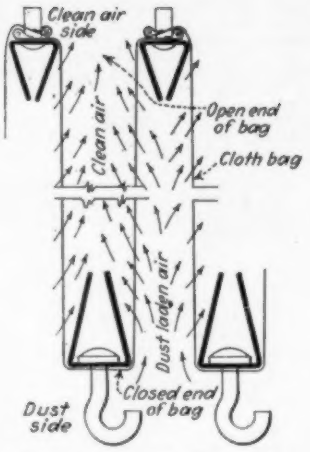
For the production of asphalt emulsions and other similar products, the Mixing Equipment Co., Rochester, N. Y., has put on the market the new "Lightnin" continuous emulsifier which is available in sizes to deliver any desired quantity of finished product. As appears from the accompanying sketch, the unit combines an arrangement of vertical and circular baffles, in combination with a number of high-speed perforated, saw-tooth-edge propellers which drive the moving fluid into ring-like motions, literally cutting it to pieces. This action, combined with an intense head-on impact between the incoming fluid and the fast moving blades, is said to produce emulsions of superior texture. The manufacturers point out that there are no grinding surfaces to wear and a minimum power requirement owing to the absence of frictional members.



Cross-section of new continuous emulsifier

Improved Dust Filter

Greatly simplified construction, making possible easy access and reduced maintenance, is an important feature of the new type EC dust filter recently introduced by the W. W. Sly Mfg. Co., 4700 Train Ave., Cleveland, O. It is also claimed that this filter offers the greatest filter area per cubic foot of filter case or per square foot of floor space. The cloth bags, with wire spacers



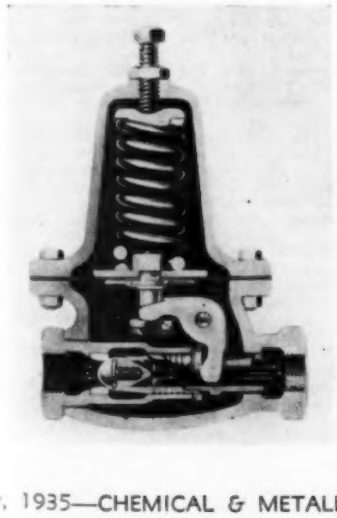
Plan section of filter bags

inside to prevent collapse under air load, are attached to the dust wall by hooking the open end over pins. The closed end is held by a hook bolt and compression spring with take-up for slack. The cleaning device consists of a shaking angle running lengthwise of the filter case, for each tier of bags. These angles jar the entire bag, loosening the dust without injury to the cloth. The drive is through a gear reduction unit to an eccentric which imparts to the shaking angles approximately 60 jars per minute. If desired, a classifier, for the precipitation of some of the dust, may be supplied.

Improved Reducing Valve

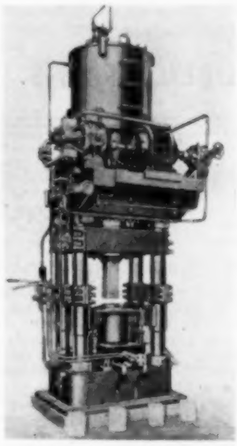
Following principles of aerodynamic design, whereby the valve proper in its standard pressure reducing valve has been given a blunt nose and a trailing edge, the A. W. Cash Co., Decatur, Ill., has developed a device which, it is stated avoids a vacuum at the trailing edge regardless of how high the fluid velocity past the valve may be. The purpose of this streamlining is to insure maximum capacity. This aim is also assisted by the elimination of the usual dividing wall, resulting in straight-line flow through the valve as is evident from the accompanying cross-sectional view. The manufacturer also points to the fact that the valve closes against the pressure and so will not chatter in service. Various sizes are available and various trims, for all fluids.

Cross-section of streamlined reducing valve



Salt Press

The accompanying illustration shows a self-contained salt press recently developed by the Hydraulic Press Mfg. Co., Mt. Gilead, Ohio. This press employs the hydro-power pressure-system previously announced (*Chem. & Met.*, p. 355, July, 1933). On this account it is possible to employ electric push-button control.



Self-contained hydro-power salt press

Pump Seal

For sealing the shafts of centrifugal and rotary pumps operating on gritty and/or corrosive liquids, the Durametallic Corp., 2104 Factory St., Kalamazoo, Mich., has introduced Dura Seal packing. A principal feature of the new packing is that it rotates with the shaft or stem, thus eliminating wear of these parts. The wear is thrown wholly on a ground joint in the seal, which offers less than one-sixth of the friction surface said to be met with in ordinary packing applications. The new seal is offered in a wide range of constructions to resist practically all corrosive agents.

Explosion-Proof Lights

Designed to meet Underwriters' Laboratories requirements for Class I, Group D hazardous locations, a new explosion-proof lighting fixture has recently been placed on the market by Benjamin Electric Mfg. Co., Des Plaines, Ill. This fixture is suitable in atmospheres containing vapors of gasoline, naphtha, petroleum, alcohol and other solvents and natural gas. It is designed for ample strength to withstand the pressure of internal explosions without breaking down or permitting flame, hot gases or sparks to escape and ignite the surrounding atmosphere. The heat-resisting glass cover is designed to withstand a hydrostatic pressure of 380 lb. per sq.in. minimum. Inspection and relamping are said to be easy. Fixtures can be supplied with either pendant type removable hoods for conduit attachment, or junction-box type removable hoods for ceiling mounting.

New lighting fixture for explosive atmospheres

New Chemical Pump

Higher efficiency than has heretofore been attained in chemical pumps is said to be developed by the new Acimet pump recently announced by the Cleveland Brass Mfg. Co., 4606 Hamilton Ave., Cleveland, Ohio. The pump is built in various machinable alloys, hard rubber and in a plastic composition of asbestos with phenol resins. It is designed so that what little corrosion unavoidably takes place will not greatly affect the performance of the pump. As additional insurance of low maintenance, all parts are interchangeable. The impeller may be removed without breaking either the discharge or suction lines. A characteristic of the design is that

High-efficiency chemical pump

efficiency remains relatively constant over a large range of deliveries.

Among other advantages claimed for this pump are its high suction lift, a low-friction packing gland, and the use of roller bearings to take up all thrusts. In most installations the pump is self-priming but for installations where an excessive length of suction piping makes them necessary, special self-priming attachments are available.

Junior Hammermill

To supply the need for small hammermills of high grade construction, the Pennsylvania Crusher Co., Liberty Trust Bldg., Philadelphia, Pa., has developed a line of junior hammermills which are said to retain the chief mechanical features of the larger units of this company's line. These mills are of the "up-running" type in which most of the disintegrating action comes from impact. They are available in two sizes, in capacities from 500 lb. to 15 tons per hour, employing rolled steel for the framework and provided with oversize roller bearings. Other features include extra large feed hoppers, tramp-iron pockets, and means for quick adjustment of the cage.

MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. American Blower Corp., Detroit, Mich.—704-page technical book, complete with charts, illustrations and tables, covering the entire field of air conditioning engineering and available from the company at $5 per copy.

Air Conditioning. Buffalo Forge Co., Buffalo, N. Y.—Bulletin 2967—12 pages on cooling and air conditioning units made by this company.

Air Filters. Coppus Engineering Corp., Worcester, Mass.—Bulletins F-320-3 and F-310-2—Descriptive respectively of air filters for motor and generator intakes and general industrial use; and filters for compressors, engines, etc.

Apparatus. Adam Hilger, Ltd., 98 Kings Road, Camden Road, London, N.W. 1, England—54-page catalog on spectroscopic instruments and other accessories.

Apparatus. Herman A. Holz, 167 East 33d St., New York City—Folder and booklet describing the Oxidator, an apparatus for determining oxygen-absorbing characteristics of organic materials.

Boilers. Union Iron Works, Erie, Pa.—6-page folder describing this company's radiant-heat boilers for industrial use.

Cement. Midland Paint & Varnish Co., Cleveland, Ohio—4-page folder describing Cleve-O-Cement, a patching cement for broken cement floors.

Chemicals. Eastman Kodak Co., Rochester, N. Y.—List No. 26—April, 1935, price list of organic chemicals offered by this company.

Chemicals. Reilly Tar & Chemical Corp., Indianapolis, Ind.—24-page booklet describing this company's coal-tar products.

Chemicals. Solvay Sales Corp., 40 Rector St., New York City—40 pages on the history, properties, uses and handling of liquid chlorine.

Cleaning. United States Hoffman Machinery Corp., Air Appliance Div., 105 Fourth Ave., New York City—Catalog A-182—16 pages on industrial vacuum cleaning equipment, its types and installation.

Colloid Mills. Chemicolloid Laboratories, Inc., 44 Whitehall St., New York City—12 pages on the construction, sizes and uses of this company's Charlotte colloid mill.

Containers. Wilson & Bennett Mfg. Co., 6566 South Menard Ave., Chicago, Ill.—128-page catalog covering a wide range of steel containers, for the products of many industries, made by this company. Includes color pages showing typical lithographed containers.

Disintegration. American Pulverizer Co., 1249 Macklind Ave., St. Louis, Mo.—8-page catalog describing small crushers and pulverizers for laboratory and small production use.

Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet 2100, 4 pages on wound-rotor induction motors; Leaflet 2183, 4 pages on Type E direct-current motors and generators.

Electroplating. The Udylite Co., 1651 East Grand Blvd., Detroit, Mich.—Leaflet describing this company's ball-type anode for cadmium plating, together with brief descriptions of a plating barrel and rheostat.

Equipment. Roots-Connersville Blower Corp., Connersville, Ind.—Bulletin 260-B14—Leaflet describing a line of condensate units for heating systems and boiler feed service made by this company.

Equipment. Stockton Chemical Engineers & Riley Boilers, Ltd., Stockton-on-Tees, England—Catalog B—22 pages on process plant equipment, including equipment for mixing and agitating, evaporating, distilling, oil extraction, oil refining, digesting, soap-making and drying.

Equipment. F. J. Stokes Machine Co., Philadelphia, Pa.—"Process News," first issue of a new house organ covering process equipment, methods and economies.

Fans. The Trane Co., La Crosse, Wis.—24-page catalog on this company's Type F.C. fans for use in heating, ventilating, drying and air conditioning. Also 4-page folder describing product coolers.

Filtration. Filtration Engineers, Inc., Summer Ave. & Erie R.R., Newark, N. J.—8-page catalog describing this company's rotary filter's use of strings in removing cake from the drum.

Fluxes. Handy & Harman, 82 Fulton St., New York City—Bulletin 9—4-page leaflet describing this company's new Handy Flux for low-temperature brazing.

Furnaces. Hevi Duty Electric Co., Milwaukee, Wis.—Bulletin HDT-235—Folder describing a high-temperature box furnace to operate to 2,300 deg. F.

Grinding. Patterson Foundry & Machine Co., East Liverpool, Ohio—Leaflet describing briefly this company's Porox 66 grinding balls and liners for ball mills.

Grinding. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin 1103—33-page catalog on ball and rod mills and accessories made by this company. Also leaflet on this company's Type TY reduction crusher.

Hose. Thiokol Corp., Yardville, N. J.—Brief data on use of Thiokol in oil-proof loading hose.

Instruments. The Bristol Co., Waterbury, Conn.—Publications as follows: Bulletin 413, Humidigraph and thermo-humidigraph recorders; 996, Instruments for air and temperature conditioning; 997, resistance thermometers; 998, humidity control.

Instruments. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.—Folder briefly describing this company's potentiometer pyrometers; folder briefly describing instruments for use in boiler rooms and plant processes.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletin 335—4 pages describing the use of instruments in removing some of the causes of high costs.

Instruments. The Foxboro Co., Foxboro, Mass.—Bulletin 200—48 pages describing orifice-type flowmeters for all purposes.

Instruments. King-Seeley Corp., Ann Arbor, Mich.—Folder describing this company's hydrostatic distant-reading level gages.

Instruments. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.—Folder describing this company's line of photoelectrically balanced potentiometer pyrometers.

Insulation. Armstrong Cork Products Co., Building Materials Division, Lancaster, Pa.—32-page catalog on cork coverings for cold lines, with description of uses and engineering data.

Lighting Equipment. Benjamin Electric Mfg. Co., Des Plaines, Ill.—Catalog 26—288 pages with complete descriptive material on lighting equipment, fittings, sockets and signals.

Lubrication. Acheson Colloids Corp., Port Huron, Mich.—Technical Bulletin H40—4 pages on the effect of foreign bodies in oil.

Materials Handling. The Jeffrey Mfg. Co., Columbus, Ohio—Catalog 565—112 pages covering a wide range of varieties of bucket elevators.

Mixers. Patterson Foundry & Machine Co., East Liverpool, Ohio—8-page booklet describing this company's Type E mixers with turbine, paddle and double-motion agitators. Also leaflet on this company's portable mixers.

Pipe Flanges. Kropp Forge Co., 5301 West Roosevelt Rd., Chicago, Ill.—4-page folder describing this company's forged pipe flanges for boilers and pressure vessels.

Pipe Flanges. Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill.—Catalog 35—96-page "text-book" type of catalog covering modern developments in forged steel flanges and weld fittings.

Piping. Tube-Turns, Inc., 435 South Fifth St., Louisville, Ky.—Bulletin on the design of modern industrial piping systems with engineering data permitting correct and economical design.

Power Generation. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin S-550-B5—8 pages on horizontal, two-cycle, gas-oil engines.

Power Transmission. Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—Book 1425—32 pages on this company's Silverstreak silent-chain drives, with description and application data.

Power Transmission. Morse Chain Co., Ithaca, N. Y.—16-page book handsomely illustrated, showing illustrations of this company's positive power transmission equipment.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: W-310-B4A, Type C, CA and CB centrifugal pumps; W-318-B6A, two-stage volute centrifugal pumps; W-320-B1, single-stage centrifugal fire pumps.

Refractories. American Refractories Institute, 1608 Walnut St., Philadelphia, Pa.—56-page directory of the American refractories industry, revised to March 1, 1935, listing brands, members of the refractories industry and geographical location of refractories manufacturers' plants. Price 25 cents to members of the refractories industry, 50 cents to others.

Refractories. Chas. Taylor Sons Co., P. O. Box 58, Annex Station, Cincinnati, Ohio—Booklet describing this company's refractory insulating brick for use to temperatures of 2,500 deg. F.

Screens. John A. Roebling's Sons Co., Trenton, N. J.—88-page general catalog covering a wide range of woven-wire fabrics made by this company.

Steel. Lukens Steel Co., Coatesville, Pa.—Chart showing sizes of sheared or flame-cut rectangular and circular plates in the standard sizes and thicknesses supplied by this company.

Steel. A. C. Murray Co., 147 Wolcott St., Brooklyn, N. Y.—1935 warehouse stock-list of boiler tubes, steel plates, sheets and shapes offered by this company.

Valves. Automatic Switch Co., 154 Grand St., New York City—24-page 1935 catalog on solenoid valves for automatic and remote control of steam, gas, liquids and air.

Valves. The Fairbanks Co., Binghamton, N. Y.—Leaflet briefly describing plug- and disk-type bronze globe and angle valves.

Valves. Jenkins Bros., 80 White St., New York City—Publications as follows: Form 159, Regrinding iron-body gate valves; 160, twin-bolt gate valves; 162, bronze gate valves.

Valves. Lunkenheimer Co., Cincinnati, Ohio—8 pages on applications of this company's Causul metal gate valves for corrosive service.

Valves. Parker Appliance Co., Cleveland, Ohio—Bulletin 38—60 pages with price list on a wide variety of valves manufactured by this company. Also, bulletin 39, 8 pages on this company's production tube benders.

Water Treatment. D. W. Haering & Co., 3408 Monroe St., Chicago, Ill.—4-page bi-monthly house organ devoted to water treatment.

Chemical Engineering NEWS

Chemical Societies Hear Talk on Heat Transfer

CHEMICAL engineering problems connected with heat transfer and with the transfer of material from one phase to another were discussed on May 10 by Prof. Walter G. Whitman of the Massachusetts Institute of Technology at a joint meeting of the Society of Chemical Industry with the New York sections of the American Chemical Society, the Electrochemical Society and the Société de Chimie Industrielle. The meeting was held at the Chemists' Club, New York, and was preceded by a dinner in honor of the speaker.

Prof. Whitman's paper was entitled "Diffusional Processes." The transfer of material and of heat from one phase to another is largely a problem of diffusion through films at the fluid boundaries. Recent work has demonstrated, however, that mixing by turbulence within the main body of fluid is seldom so complete that non-uniformities can be disregarded. He cited numerous examples of transfer problems which are dominant in the practical operations of chemical industry. He showed that apparently diverse phenomena could be correlated by simple generalizations and emphasized the value of such correlations in the work of the chemist and chemical engineer.

Prof. Whitman was formerly associate director of research of the Standard Oil Company of Indiana. Last fall he was appointed head of the Department of Chemical Engineering at the Massachusetts Institute of Technology.

Petroleum Technologists Hold Conference

THE seventh regular meeting of the Cracking Development Conference occupied a three-day session, ending May 2, and centered in New York with the Hotel New Yorker as headquarters. The program included an inspection trip to the Bayway refinery, and on the evening of May 2 the Standard Oil Co. of New Jersey group played hosts at a dinner to those attending the conference. Previous meetings of the Cracking Development Conference, which is attended by petroleum technologists and executive representatives from the participating company groups, have been held at Whiting, Ind., New York, and Port Arthur.

Participating at the recent conference were representatives of the Standard Oil Co. (Indiana), The Texas Co., The Standard Oil Co. of New Jersey, Gasoline Products Co., Inc., and The M. W. Kellogg Co. William F. Moore, vice-president and general manager of Gasoline Products Co., who is general chairman of the Cracking Development Conference, presided at the sessions.

The purpose of the conference is to review technical developments and to consider methods of processing and equipment applicable to the cracking field. As cracking technology becomes more complex and its literature voluminous the conference is found increasingly valuable as a coordinator of results. It acts as a committee on standards used in the design of equipment and serves as a clearing house for improvements in processing methods.

The coordination of research and development by company groups participating in the conference is in line with the increasing general importance which cracking assumes in view of the demand for improved gasoline adaptable as motor fuel for engines designed for higher compression ratios.

Stay Granted on Provision In Paint Code

SELLING below cost provision of the paint, varnish and lacquer code has been stayed until June 16, under an order announced on April 29 by the National Industrial Recovery Board.

The stay was granted at the request of the Paint Industry Recovery Board. In its petition it was stated that the entire article was ineffective due to the expiration on Jan. 26, 1935, of the processing and packaging cost schedules which were submitted to N.R.A. in accordance with Section 4 of the article.

These schedules which the industry held were necessary in the enforcement of its cost finding system, were originally approved by N.R.A. and became effective for a 60-day period beginning Nov. 26, 1934, but were not extended by N.R.A.

New Loans Available for Naval Stores Trade

LOANS to producers of gum turpentine and gum rosin who are signatory to the marketing agreement for the industry were authorized on April 26 by the Commodity Credit Corporation upon recommendation of A. A. A.

The new loans will mature March 31, 1936. They will be made on the basis of $50 per unit. The loans will be made directly by C. C. C. through the Jacksonville loan agency of R. F. C.

Fifty per cent of the marketing allotment granted to each individual producer by the control committee, for the period from May 1, 1935, to Oct. 1, 1935, will be eligible for loans. Since 64 per cent of the year's crop is produced within the above period, 32 per cent of the individual producer's annual marketing allotment will be immediately eligible for loans.

Under the new program the $50 unit loan value is to be applied on a basis of 48 gal. barrel of turpentine; $5.50 per market barrel of approximately 280 pounds weight for grades X and WW rosin; $5 per barrel for grades WG and N; $4.50 per barrel for grades M, K, I, H and G; $4 per barrel for grades F, E and D, and $3.50 per barrel for grade B.

E. M. Allen Will Address Purchasing Agents

THE annual convention of the National Association of Purchasing Agents will be held at the Waldorf-Astoria Hotel, New York, May 20-23. The general theme of the convention discourses will be "National and International Governmental Policies as They May Affect Commodity Prices." On May 20 an address on "Heavy Chemicals" will be delivered by E. M. Allen, president of the Mathieson Alkali Works.

Conference on Glass Problems at Urbana

THE Department of Ceramic Engineering at the University of Illinois announces that plans are being made for holding a Third Conference on Glass Problems, which will be held about June first at Urbana, Illinois.

It is expected that the program will include some very interesting papers on glass tank operation, glass tank insulation, and the use of cullet. A questionnaire dealing with these problems is being prepared for distribution.

NEWS FROM WASHINGTON

By PAUL WOOTON

Washington Correspondent of Chem. & Met.

INTERNATIONAL problems affecting process industry are growing in importance daily in Washington. A score of these could be cited. But most of them conform to a common pattern of panacea-seeking. Some of the more important or novel ones do, however, deserve mention:

1. Canadian trade-agreement negotiations may develop the most serious chemical problems of all for process industry. Definite proposals are being considered for a 50 per cent cut in certain tariffs, notably some electrochemical products.

2. Most-favored-nation treaty provisions continue to apply. If concessions are made to Canada on chemicals these would apply to most other nations. Japan would be particularly favored because of the low labor costs. Critics of the Canadian negotiations argue, probably rightly, that the Japanese would get the new business, not the Canadians, if chemical tariff rates are cut.

3. Cocoanut oil prices have gone down again. This has occurred despite the processing tax which was expected to hold this vital soapmaking material at a higher price level. It simply means that we are taking the processing tax out of the raw-material producers of the Philippines. In this respect the Filipino is not faring much worse than some of the "benefitted" farmers under A.A.A.

4. Procedures under N.I.R.A. to give added tariff protection to commodities which, because of N.R.A. wage increases, are threatened by new imports, simply do not function. No well-informed Washingtonian expects any of those making appeals for chemicals, notably natural salt cake, to fare any better than pig-iron producers have. Official inquiries are made when formal appeals are entered, but no tariff adjustments follow. Despite this fact there is constantly growing sentiment in Washington that some form of import quotas will have to be fixed unless our tariff horse-trading enables us to abolish that practice on the part of the other major industrial nations.

5. Strategic minerals, both the rarer metals and the non-metallics difficult to find in the United States, are receiving new attention. But the panacea here is the proposal that the Bureau of Mines go into the mining business to produce these commodities for Uncle Sam from submarginal properties (S. 1476). And the Navy, too, is asking for funds to buy reserve stocks of strategic metals from American producers as a measure of war-time preparedness. The House committee has granted $7,500,000 in this year's appropriation bill for this purpose. Neither plan goes to the root of these international problems.

6. Starting its inquiry to determine why Japan was suddenly taking large quantities of tin-plate scrap, a House special committee conducted an extended investigation. Now we have an 1,100 page document giving a report on this tin investigation, a very valuable compendium of information, and much misinformation in the part which is testimony. Also there is a bill (H.R. 7675) which proposes not a tin agency, but a "Board for Strategic Materials." As proposed, this board would have authority to make technical and economic studies, formulate fundamental national policies, plan for resource development, and do extensive industrial research. The initial appropriations are modestly (?) $375,000 a year, all to be allotted to tin studies or search for tin substitute.

Legislation

The above legislation centering around the problems of international character is minor relatively in the Washington picture. Of much greater importance are the fundamental Administration measures affecting banking, public utility holding companies, social security, labor relations, and new taxes. These quintuplets are virtually the Administration family of "must" subjects for legislation. And no one should forget that new taxes will come, and plenty of them, late in the present session.

Of almost equal importance, however, are the four measures extending or enlarging the authority of A.A.A., T.V.A., H.O.L.C. (more money), and N.I.R.A. The trend of thinking in Washington for the past month has been toward the simple expedient of extending N.I.R.A. for another ten months or a year. By that plan the members of Congress would escape the hazardous decisions involved in voting on specific parts of the bill. Many such decisions would be called for if a new act were to be substituted and somebody back home would be offended no matter what the vote was. Mere extension escapes most such complications.

The principal modification of N.R.A. policy expected is a curtailment of the right of industries to use price controls of any sort. Only the natural resource industries are likely to be encouraged to continue such measures after the expiration of present codes, most of which are terminated June 16.

Opposition to mere extension of N.R.A. comes from Donald Richberg and other lawyers of the New Deal. They would like a new act so that all other cases under the old would become moot. Thus they would postpone the possibility of fundamental reversals by the Supreme Court, a hazard all too clear to them and really much feared despite public protestations to the contrary.

Labor Plans

The Administration is not under any circumstances going to allow much backsliding from the fundamental principles of limited hours, minimum wages, and no child labor. Whatever form new legislation takes, these three principles will be basic to all Administration supervision, unless perchance the Supreme Court enters with a most unexpected form of unfavorable decision.

If N.I.R.A. is extended without fundamental modifications of labor provisions, it now appears that neither the Black bill fixing limited hours by law nor the Wagner labor-relations bill would need to be pressed to immediate enactment. But neither measure is as yet dead. The Black type of regulation is, however, much farther in the background at this time. If neither of such bills is enacted, then at least the chemical industry can go forward under the Chemical Alliance type of code without any fundamental change.

Stream Pollution

A plan for Federal Government controlled and aided elimination of stream pollution has been recommended to Secretary Ickes by the Natural Resources Board for inclusion in the Administration's works relief program, according to information reaching legislators interested in the problem.

The Natural Resources Board's special report on the question, which was made some time ago, but has not been made public yet, follows along the line of the recommendations accepted by conferees who attended a meeting Secretary of War Dern called on the subject last year, it is stated.

That plan called for a strong federal authority, either an existing agency or a new one to be set up, that would send out engineers with plans showing

municipalities and industrial plants how they could cooperate in the conversion of waste and in elimination of sewage. The authority would be empowered to require this action if cooperation was not forthcoming. Government loans would be provided for those cooperating, and the program would be worked out in cooperation with existing state boards having control over the matter.

Senator Lonergan of Connecticut, one of the leaders at the conference sponsored by Secretary Dern, is ready to sponsor legislation calling for the conference's program if the Natural Resources Board's recommendations do not go far enough along that line. It is understood, however, that if the Board's suggestions are close to it he is willing that they be accepted as he would like Administration support for his bill if introduced.

Petroleum Institute Petitions Congress

DIRECTORS of the American Petroleum Institute, meeting in an eight-hour session at Chicago on May 3, unanimously adopted a petition to Congress opposing the Harrison Bill and similar "economic straitjackets" providing for enlargement of the NIRA, urging that governments of oil-producing states be encouraged to exert their power to regulate production of crude oil and natural gas, and suggesting a course of action for the federal government in enacting legislation directly affecting the petroleum industry.

The six-page petition, which is to be filed with Congress next week, established five principles which, the Board of Directors said, materially would assist in stabilizing conditions under which the petroleum industry can operate to direct advantage of both makers and users of petroleum products.

The first principle called for minimum regulation so that private industry may be free to serve the public most efficiently and economically. The second principle urged encouragement of state governments in regulation production of crude oil and natural gas to prevent waste.

Du Pont Acquires Assets Of Acetol Products

ANNOUNCEMENT was made early in the month to the effect that E. I. du Pont de Nemours & Co. had acquired all the assets of Acetol Products, Inc. The du Pont company has been a partial owner of this concern since the acquisition of the Newport Chemical Co. in 1931. Recent action by stockholders of Acetol Products, Inc., resulted in the sale of the balance of the assets to the du Pont company.

Alcohol-Gasoline Blends Main Topic At Dearborn Conference

NEARLY 150 men prominent in agriculture, industry, and science met in a two-day conference at Dearborn, Mich., on May 7-8. The conference opened with the signing of a document called "A Declaration of Dependence Upon the Soil and of the Right of Self-Maintenance" which was tantamount to a declaration of the economic independence of the country.

Francis P. Garvan, of New York, president of the Chemical Foundation, was elected permanent chairman of the conference and Carl B. Fritsche, of Detroit, permanent secretary.

Mr. Garvan stated that the services of 20,000 chemists and \$30,000,000 worth of equipment associated with chemical production was at the disposal of American industry and agriculture in their attempts to achieve mutually profitable cooperation.

Describing the profit motive as the catalyst in the economic system, Irenee du Pont, vice chairman of the board of E. I. du Pont de Nemours & Co., said: "Eliminating the catalyst is now the chief cause of the delay of complete recovery.

"Has not the urge for profit been largely removed by confiscatory taxes and propaganda disparaging bonuses and what is referred to as 'excess profits'?" Mr. du Pont said. "The demagogue's hypocritical cry 'divide the wealth,' if followed, would take away incentive, not only of future progress, but also of further production so that there would be in the future continually less to divide. Looking to the well-being of the average man, he should control his envy and encourage those who advance his interests by permitting large reward for accomplishment."

Dr. Charles H. Herty spoke on the development of newsprint and book paper from southern pine and also of the use of pine pulp in rayon manufacture.

The high light of the conference centered in the discussion of the advisability of converting farm products into alcohol for admixture with motor gasoline.

Dr. L. M. Christensen, of Ames, Ia., representing the Chemical Foundation, submitted a 19-page report in which he contended that exhaustive tests with automobiles, trucks, buses, tractors and airplanes had proved that, as a blend with gasoline, alcohol was unexcelled. No change in present engine design had been necessary.

A mixture of one gallon of the alcohol with ten of low-grade gasoline had, Dr. Christensen asserted, given 8 per cent better mileage and the same anti-knock rating as "regular" grades of gasoline, while a 20 per cent blend had equaled in performance the best of the premium fuels. In addition, the blend gave smoother and quieter engine operation, virtual elimination of gum and carbon, better acceleration, particularly at low speeds, and somewhat easier starting.

"If agricultural alcohol becomes our future motor fuel," he declared, "from 80,000,000 to 100,000,000 acres will be necessary to supply the 25,000,000,000 gallons required annually. At 15 cents a gallon this should yield the American farmer \$5,000,000,000 for his crop."

William J. Hale, consulting chemist of Washington, D. C., expressed the opinion that the world was in the midst of a chemical revolution as profound as was the mechanical revolution of the last century.

"To alcohol we look today for the chemical means of stabilizing all agriculture," Hale said. "Different sections of the country will send different crops to its fermentation industries—in the South, the sweet potato; in the North, the potato and sugar beet; in the Middle Belt, corn, fruits and the Jerusalem artichoke, and everywhere waste wood, weeds and other undesired materials. Everything that grows can be hydrated and fermented into alcohol."

J. R. Heiple, vice-president of the State Bank of Gridley, Ill., contended that, from the viewpoint of the country banker, the manufacture of industrial alcohol offered the best present opportunity for the utilization of excess agricultural products.

The American Petroleum Institute in a letter sent to the Conference called upon the Chemical Foundation to join with it in financing an impartial investigation of the relative merits of alcohol-blend and straight gasoline motor fuels. Pres. Axtell J. Byles, of the Institute, said his organization was ready to assume one half of the expense of an impartial, economic, and technical investigation by competent disinterested experts. He suggested that the total cost should not exceed \$30,000, with Foundation and Institute each paying one half of whatever expense was incurred.

"It is probably unnecessary to state," President Byles wrote, "that the petroleum industry does not share the optimism expressed by your organization as to alcohol-gasoline blends.

NEWS FROM ABROAD

By Special Correspondents of Chem. & Met. at London and Berlin

London

THE annual report of Imperial Chemical Industries is interesting. There has been a slight increase in dividend from 7½ per cent to 8 per cent, which corresponds approximately to the declared increase in net income, total of which is $30,000,000. Formerly sale of alkali was the profitable mainstay but cannot now be so confidently relied upon; nitrogen fertilizers did not justify the capital expenditure, and effort is being made to wipe out the capital loss which has to be faced. A start was made by transferring part of the capital assets to the new oil from coal plant at Billingham, which has started successfully, and a further step is the proposal made to convert the 10/- deferred shares to ordinary shares at the rate of four 10/- deferred shares for one ordinary share of £1. This will reduce the capital by about $20,000,000. The present rate of distribution of 8 per cent on ordinary shares, corresponds this year to 2 per cent on the deferred shares, and therefore the movement is eminently favorable, corresponding to the market price of the shares, and had the net income been greater, the proposals might have been less acceptable than now seems likely.

Courtaulds, Ltd., have also presented a highly favorable report disclosing a liquid position of great strength, and a determination to take full advantage of the increasing rayon output by the building of another factory to cost $30,000,000. The position of the acetate silk producers is becoming less favorable, owing to competition from the finer counts of viscose rayon, but on the other hand there is an expanding market for knitted goods.

A report of outstanding interest is that of the Sofina (Société Financière de Transports et D'Enterprises Industrielles) at Brussels, which has large shareholdings in electricity undertakings and other concerns throughout Europe. The managing director, Dannie Heineman, prepares every year a detailed report which is an economic digest of the European situation which relates to world trade. The report is obtainable through the head office of the Midland Bank in London. Incidentally, Brussels is becoming a center of interest, not only through its devalued currency, but also on account of the Brussels Exhibition just opened, and which is reported to be of great interest and some architectural beauty. Judging by the photographs, it is a miniature Chicago World Fair, but more highly specialized.

As a result of the gold and silver boom, capital of the successful mining companies is being diverted in new directions, one of these being the extraction of oil from the Torbanites of South Africa, a project which has been attempted with varying success for the last twenty years. Now, partly under government auspices, a large plant is under construction, and the sponsors have wisely adopted the Salerni report, which has been carefully developed during the last few years by Salermo, Ltd. This firm has just published a booklet, which is quite a model of its kind, inasmuch as it is scientifically accurate and states the facts without any apparent exaggeration. The results obtainable with Torbanite are very impressive, and the booklet should be obtained by all concerns which may now or later consider entering the low temperature carbonization field, whether in coal, shale or Torbanite.

Among other items of passing interest might be mentioned the increasing use of thick chromium deposits direct on steel, which are being increasingly adopted for dies in the molding industry, and for tools in machine shops. Deposits up to 3 or 4,000ths of an inch are now quite common, and meanwhile, the processes and methods used for custom plating have also been brought up to a higher standard which encourages a wider use in different applications.

A new electric razor of British manufacture is shortly to be put on the market. The Telerazor, as it is called, does not use an electric motor nor a moving blade, but a small vibrator in the handle of the razor operated by a 1½-volt battery, also in the handle, gives the necessary oscillation of about 200 per second required for the shearing action which is claimed. The razor is surprisingly effective, and caused quite a sensation when it was exhibited at the British Industries Fair.

Holbrook Gaskell, until recently chairman of the general chemical group of Imperial Chemical Industries, has been elected to a seat on the board; this to some extent maintains the family tradition, a forebear having been in charge of the Gaskell Deacon works of the United Alkali Co.

Berlin

NET PROFIT of 51,000,000 Rm. for 1934, against 49,000,000 in the preceding year is reported by I. G. Farbenindustrie A. G. which again declared a dividend of 7 per cent. Number of men employed increased from 113,000 to 135,000. Sales of dyes showed an increase, with a small drop in overseas exports, and with exports to other European countries practically unchanged. New developments and further agreements with the most important European competitors left the European dye market in a fairly stable condition. According to reports the overseas market was less favorable on account of the pressure exerted by Japanese competitors, which affected all but special products. The increase in sales of chemicals continued at an accelerating rate, although the export market was adversely affected. In the oil field emphasis was placed on the progress made in the direct hydrogenation of coal and lignite. The estimated 1934 production for the Leuna plant was reached, although no figures for capacity were released. Tests in Ludwigshafen with hydrogenation of coal confirmed the previous experience that this process is capable of competing with proper tariff protection; nothing was stated, however, regarding the possibility of large scale production at this plant.

Table I shows the value of German chemical exports, in relation to total exports, while Table II shows the distribution to the various parts of the world for 1933 and 1934.

Table I—German Chemical Exports, Compared With Total Exports in million marks

Year	1929	1931	1932	1933	1934
Total exports....	13,483	9,599	5,739	4,871	4,167
Chemical exports.	1,420	998	726	695	658

Table II—Distribution of German Chemical Exports in million marks

	Chemical Exports			Per Cent of Total Exports	
	1933	1934	Change	1933	1934
World........	694.6	657.8	— 5.3	14.3	15.8
Europe.......	431.7	407.5	— 5.6	11.4	12.8
Overseas.....	262.8	250.3	— 4.8	24.6	25.6
Africa.......	12.1	12.5	+ 3.3	11.4	11.7
America....	118.2	105.6	—10.7	20.9	23.5
Asia........	112.3	112.5	+ 0.2	30.5	28.6
Australia...	5.8	4.9	—15.5	21.8	19.2
Not Specified.	14.4	14.8	+ 2.8	....	....

After extensive preliminary tests the first European lignite gas plant was started in Kassel. Allner, Chief Chemist of Braunkohlen u. Brikettindustrie A.G. (Bubiag) has constructed the so-called Kassel chamber, the Bubiag-Didier system (German Patent 602,211 and 606,809). All types of lignite, even the poorest qualities, may now be gasified in a chamber made from ceramic material. In the near future this gas may be expected to be cheaper than gas from ordinary coal distillation. Production at Kassel has already reached 3,000,000

cu.m. gas annually, used in households and industrial plants, directly or mixed with city gas.

Preussische Bergwerks-u. Hütten A.G. has erected an intermediate-temperature coking plant at Barsinghausen. This plant, which formerly marketed only unwashed coal, has now a flotation plant where coal of low ash is produced. This coal then goes to a battery of 29 Koppers ovens, which, on account of the peculiar nature of the Barsinghausen coal, operate at a temperature of 700 deg. C., producing a material very similar to anthracite, which is excellently suited for domestic use and for gas producers in motor vehicles. In addition a high yield of oils and motor fuels, and a valuable gas are obtained.

After many unsuccessful attempts Gastechnik G.m.b.H., Oberhausen, has apparently solved the problem of pressing the iron oxide, used in purification of gas, into balls. They thus obtain the iron oxide in a shape that resists all attacks in the purification, regeneration, and extraction processes, and which, on the other hand, is so porous that the gas can completely penetrate the balls. A purification unit of this type, charged with balls of Lux mass of 10-12 mm. diam. is now in operation, for comparison with the oxide boxes regularly used. It takes up a small place and is very simple in operation. Two cylindrical towers of sheet iron are used, operating intermittently, one working on the gas while the other is being regenerated by the action of air. On account of the cylindrical shape the apparatus is also adapted to purification under pressure. It has also been found economical for purification of lean gas, formerly not feasible on account of the high installation cost. A cubic meter of tower space holds about 700 kg. active iron oxide, while the regular boxes hold only about 330 kg. loose mass. An increase in the velocity of the gas from 5-7 mm./sec. to 100 mm./sec. is also feasible.

Another new wet purification process for gas involving a specially constructed washer directly following the tar scrubbers, that is, ahead of the ammonia washers, has been constructed by Rostin. The wash solution is made by passing sulphur-free ammonia water over copper oxide, which is dissolved, producing a solution with 9-10 g. copper per liter. The dissolved copper has a great affinity to the hydrogen sulphide of the gas, forming copper sulphide when an excess of copper is present in solution. The wash liquor discharges to a filter where the precipitate is retained and the filtrate is then again allowed to build up in copper, while the precipitate is roasted to SO_2 and copper oxide which is returned to the process. With the purifier ahead of the ammonia washers the escaping ammonia is recovered, while the solution is constantly being enriched by the ammonia in the gas. The Rostin process insures complete removal of the sulphur in the gas, and no subsequent dry purification step is needed as in many other wet processes. Tests over many months have given favorable results.

In the Fall of 1934 a plant for removal of the poisonous constituents of gas was started in the Hameln gas works. The process is based on the water gas reaction, as the gas is mixed with steam in ratio of six times its content of carbon monoxide and passed over catalysts at 400 deg. C., whereby the content of monoxide drops from say 21 per cent to 0.4-per cent. By the use of heat interchangers the heat losses in the process are kept at a minimum. After cooling of the gas the hydrogen sulphide formed from the organic sulphur compounds is absorbed in dry purification boxes. Hydrocyanic acid, naphthalene and organic sulphur compounds are materially reduced. Following the success at the Hameln plant the decision has been made to treat the gas at the Hamburg gas works by a similar process. In this case the carbon monoxide will be converted into methane by the aid of nickel catalysts, at a temperature of approximately 300 deg. C.

To promote the use of wood gas for operation of motor vehicles the Government is now going to assist financially those who buy new motors or who want to equip their old machines for the new type of fuel. Furthermore, at convenient locations will be built service stations where the Department of Forestry under certain conditions will sell wood at half the market value. A kilogram gas wood costs 0.03 Rm.

A cracking process for lignite tar has been developed in the Rositz refinery of Deutsche Petroleum A.G. Almost all German lignite tars may be used for this process, provided the following limits are not exceeded: sulphur, 2.5 per cent, creosote, 20-22; asphalt, 3 per cent. The reaction chamber method is not suitable for cracking as the low hydrogen content of the lignite tar causes coking which rapidly interrupts the operation. This precipitation of carbon is caused by the low velocity due to the large volume of the chamber and the resulting overheating. Cracking in coils of correct dimensions is said to overcome this defect, particularly when the heat is so regulated that the temperature drops occurring in the coil are small. Acid oils and cresols are removed from the gasoline by washing with dilute sodium hydroxide, which is regenerated with flue gas and lime. This is followed by sulphuric acid washers and redistillation, leaving a motor oil; the highly antiknock gasoline produced is marketed under the name Dealin. A gasoline yield of 35 per cent, and a total yield of 60 per cent of motor fuel is attained.

Annual Student Awards Made by A.I.Ch.E.

On May 13, Burwell Spurlock of York, Neb., senior at the College of Engineering, University of Colorado, was awarded a $100 first prize in a nation-wide contest, involving the solution of a problem in chemical engineering, sponsored by the American Institute of Chemical Engineers. Second prize of $50 was awarded Roland Voorhees of Chicago, who graduates next month from Princeton; while third prize of $25 went to Edward A. Belmore of Crozet, Va., a senior at the University of Virginia. Two other contestants won honorable mention, John A. Crowley, Jr., of Charlotte, N. C., a student at Yale University, and Arthur Allyn MacPhail of Salida, Colo., a senior at the University of Colorado.

The problem, formulated by the Institute's committee, was an extremely practical one, calling not only for the application of chemistry, chemical engineering and machine design, but also plant economics and accounting. The contestants were required first, to select equipment for the recovery of acetone from a mixture of acetone and air by means of an absorption tower, using water as the absorbant. From this the most economical design had to be deduced and the annual operating cost predicated. In addition, the student was called upon to design certain required auxiliaries, such as a heat exchanger, a condenser and a still boiler. Finally an economic balance had to be struck, yielding as a solution the combination of equipment having a minimum cost.

China Operates Modern Alcohol Distillery

A MODERN alcohol distillery with a daily output of 7,000 gallons, and staffed entirely with Chinese, recently commenced operations at Shanghai, according to information received in the Commerce Department's Chemical Division.

The plant, constructed under the auspices of the Chinese Ministry of Industries, was completed in record time, having been commenced in May, 1934, and ready for operation on December 16 of that year. An eight-hour working day, new for China, will be in effect.

It is claimed that either grain, potatoes, or molasses may be used as raw material by the distillery and the output is said to be standard in quality, running from 96 to 97 per cent pure.

The management of the enterprise plans later to produce "dry ice" as a byproduct, utilizing the carbon dioxide which is produced in the distillation process. It is estimated that 20 tons may be produced daily.

NAMES *in the News*

Ralph M. Roosevelt has been elected president and a director of the Titanium Pigments Co., New York. He succeeds W. F. Meredith, who has been made chairman of the board of directors. The new president was formerly vice-president of Eagle-Picher Lead Co.

Charles L. Faust has become associated with the technical staff of Battelle Memorial Institute, Columbus, Ohio, as electrochemist. Dr. Faust received his Ph.D. degree in chemical engineering, in 1934, from the University of Minnesota.

H. R. Nelson has joined the Battelle Memorial Institute technical staff. Dr. Nelson will be in charge of one of the research projects at the Institute. He is a graduate of Amherst College and Cornell University.

K. S. Rohrbough is now chief chemist for the Majestic Milling Co., Aurora, Mo.

A. R. Duvall of Oliver-United Filters, Inc., for several months has been in Queensland, Australia, and Manila, P. I. Business takes him next to Tokyo, Japan, where he expects to remain until October.

Fred E. Schmitt is now in the technical publicity department of the Union Carbide & Carbon Corp. Formerly, he was with A. A. Lund & Associates and the General Chemical Co.

Willard M. Allen of the University of Rochester was awarded the first Eli Lilly & Co. Award in biological chemistry carrying $1,000 in cash and a bronze medal.

George D. Bearse, who was general manager of the Dalhousie, N. B., plant of the International Paper Co., is now in the same capacity at the Buckport, Maine, plant of the Maine Seaboard Paper Co.

W. Hobart Duff, of Crossle & Duff Pty. Ltd., Melbourne, Australia, representative of the Dorr Co., is visiting in the United States.

Bachrach

Julius A. Nieuwland

Julius A. Nieuwland of the chemical department at the University of Notre Dame during the Chemical Industries Tercentenary celebration received the William H. Nichols medal from the New York Section of the American Chemical Society. The award was made to Father Nieuwland for his work on synthetic rubber.

V. Weaver Smith on May 1 became vice-president in charge of business activities of the Broderick Manufacturing Co., Muncie, Ind. He was formerly with the Lummus Co.

John Chipman has joined the research staff of American Rolling Mill Co. as associate director. For six years he was research engineer in the department of engineering research at the University of Michigan.

Myron A. Coler has been awarded the seventh Western Fellowship of $1,000 by the Electrochemical Society. Mr. Coler will carry out his research on electrophoresis at Columbia University. The fellowship was founded by Dr. Edward Weston, one of the foremost pioneers in electrochemistry.

Karl M. Herstein has opened a consulting office in the Chemists' Club Building, New York.

W. A. Noyes, director emeritus of the laboratories of the University of Illinois, has been awarded the Priestley Medal, presented every three years by the American Chemical Society as its highest award for distinguished service to chemistry.

Samuel J. McDowell, formerly of the A. C. Spark Plug Co., has accepted the position of superintendent of the Keasbey, N. J., plant of General Ceramics Co.

Edward R. Weidlein has been awarded the Chemical Industry Medal for 1935 by the American Section of the Society of Chemical Industry. This award is made annually to a person who has made a valuable application of chemical research to industry, primary consideration being given to applications in the public interest. Presentation of the medal will be made in the fall.

R. M. Fuoss has recently joined the staff of Gustavus J. Esselen, Inc., in an advisory capacity. Dr. Fuoss recently returned to this country after studying at the University of Leipzig with Professor Debye and at Cambridge University with Professor Fowler.

Myron H. Blanchard recently joined the Quigley Co. to take charge of sales engineering.

F. D. Rossini of the Bureau of Standards was presented the Hillebrand Award of the Washington Section of the American Chemical Society. The award was made in recognition of his fundamental work on the thermochemistry of hydrocarbons and alcohols.

A. W. Robinson, cement plant engineer with the Oliver-United Filters, Inc., is on a business trip to the Argentine.

Bernard H. Porter has joined the technical department of the Acheson Colloids Corp.

Norman Clark, formerly of Louis De Jonge Co., Staten Island, N. Y., is now in the research department of the Michigan Paper Co., Plainwell, Mich.

Leslie Cleminson, who was in the chemical laboratory of the Smooth Rods Falls, Ontario, plant of the Abitibi Power and Paper Co., is now manager of the mill.

Oliver F. Redd has joined the research department of the Patterson Foundry and Machine Co. Mr. Redd was educated at the University of Illinois, the University of Chicago and the Southern Illinois Normal, and for several years has been engaged at the Bell Telephone Laboratories.

J. THOMPSON BROWN, vice-president of E. I. duPont de Nemours & Co., has been invited by the Secretary of the Interior to be a member of the Advisory Board to the Bureau of Mines.

NATHAN R. PIKE, formerly with the Brown Co., Berlin, N. H., is now with the Nulomoline Co., New York.

H. A. EVANS, chemical engineer and executive of the Sulphide Corp., Ltd., Boolaroo, Australia, has been visiting cement, potash and electrochemical industries in the United States.

EVERETT B. INGALLS is now with the S. D. Warren Co., Cumberland Mills, Maine. He was formerly manager of the Palmer, N. Y., mill of the International Paper Co.

E. D. ALBERT, formerly connected with the Consolidated Film, Inc., is now associated with the Keystone Varnish Co. as chemist.

W. G. KUCKRO, a chemical graduate of St. Johns College, Brooklyn, N. Y., is now employed in the chemical laboratory of the Lurgi Corp.

V. E. OSTERBERG, formerly employed as chemical engineer with the Combustion Utilities Corp. and the M. W. Kellogg Co., has joined the staff of the American Bank Note Co.

THOMAS J. SCHOCH has joined the B. P. Ducas Co., New York. He was previously employed as a chemist with the United Fruit Co. and the Stein, Hall Co.

C. A. HOGENTOGLER and E. A. WILLIS have been awarded the Charles B. Dudley medal for 1935 by the American Society for Testing Materials.

This medal is awarded annually to the author of the paper presented at the preceding annual meeting which is of outstanding merit and constitutes an original contribution to materials research.

H. S. VASSAR, laboratory engineer, Public Service Electric and Gas Co., Irvington, N. J., has received the nomination as president of the American Society for Testing Materials.

H. E. WIEDEMANN, consulting chemist, St. Louis, has been elected national president of Alpha Chi Sigma at the last conclave.

MYRON A. SWAYZE, who for a number of years has been research director of the Lone Star Cement Co., has been made research director of the International Cement Corp. He will continue to make his headquarters in Hudson, N. Y.

F. A. LIDBURY, president and general manager of the Oldbury Electro-Chemical Co. and a director of the Electric Reduction Co., Ltd., of Canada, has been awarded the fifth Schoellkopf medal of the Western New York Section of the A.C.S. The medal was awarded Mr. Lidbury for his many contributions to the science of electrochemistry and executive services in American chemical industry.

F. A. Lidbury

CALENDAR

AMERICAN ASSOCIATION OF CEREAL CHEMISTS, annual meeting, Denver, June 4.

CANADIAN CHEMICAL ASSOCIATION, annual meeting, Kingston, June 4-6.

AMERICAN ELECTRO-PLATERS' SOCIETY, annual meeting, Bridgeport, Conn., June 10-14.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Detroit, June 24-28.

AMERICAN CHEMICAL SOCIETY, San Francisco, week of Aug. 19.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, fall meeting, Atlantic City, week of Sept. 16.

ELECTROCHEMICAL SOCIETY, semi-annual meeting, Washington, D. C., Oct. 10-12.

AMERICAN PETROLEUM INSTITUTE, annual meeting, Los Angeles, Nov. 11-14.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting, Columbus, Ohio, Nov. 21-23.

EXPOSITION OF CHEMICAL INDUSTRIES, New York, week of Dec. 2-7.

OBITUARY

CHARLES F. CROSS died April 15 at Hove, Sussex, England. He was 79 years old. Early in 1895 he and Edward J. Bevan developed the viscose process of producing rayon. Although their discovery was hailed in scientific circles, it was not until the War, when silk became scarce in many parts of the world, that a real effort was made to commercialize their development.

JESSE ERWIN DAY died April 20 of a heart ailment at his home in Columbus, Ohio. He was professor of chemistry at Ohio State University, where he had been a member of the faculty since 1913. Previously, he had taught chemistry at Louisiana State University and the University of Wisconsin.

ALFRED I. DUPONT died of a heart attack April 29 at his home, Epping Forest, near Jacksonville, Fla. He was 70 years old. In 1902 Alfred duPont took over and reorganized the duPont powder company. Fourteen years later he retired as vice-president and general manager and moved to Florida where he continued to make his home.

ERNST BISCHOFF, president and a director of the company bearing his name, died suddenly April 19 of a cerebral hemorrhage at his home in New York. He was 71 years of age.

FREDERICK M. CHASE, consulting engineer and vice-president of Commercial Solvents Corp., died unexpectedly April 30 at his home in New York. He was formerly with the New Jersey Zinc Co. and associate of Bernard M. Baruch, chairman of the War Industries Board during the World War.

JOHN HILL WHITING, chairman of the board of the Whiting Corp., Harvey, Ill., died April 6. He was 85 years old. Mr. Whiting's rise from obscurity to a position of business leadership was characterized by hard work and clear vision.

EDGAR FIELD PRICE, formerly vice-president of the Union Carbide and Carbon Co. and one of the engineers responsible for the early production of acetylene, died at his home at Port Chester, N. Y., on April 16. He was 62 years old.

JOHN L. R. MORGAN, professor of physical chemistry at Columbia University, died April 12 of pneumonia in the Columbia Presbyterian Medical Center, after an illness of five weeks.

Chemical ECONOMICS

BUSINESS activity in March fell off slightly from the January and February levels, the Federal Reserve Board reported in its monthly business survey.

Industrial output in March, according to the board's index, amounted to 88 per cent of the 1923-25 average, compared with 89 per cent in February and 90 per cent in January. In March, 1934, the index stood at 84 per cent.

Volume of industrial production, which usually increases somewhat at this season, showed little change in March. Building activity in the residential field increased in March and the first half of April, reflecting in part seasonal factors. Wholesale prices of farm products and goods, after declining in March, showed a considerable increase in the first three weeks of April.

Steel production, after declining in the latter part of February, showed little change during March and the first three weeks of April. Output of automobiles increased further and was larger than in the corresponding period of any other year since 1929.

In the cotton textile industry daily average output declined in March and, according to trade reports, showed a further considerable decrease in the early part of April. Activity at woolen mills also decreased somewhat in March, while shoe production showed little change.

The accompanying table presents a comparison of different branches of the chemical industry so far as activities in the first quarter of the year are concerned. It will be noted that the glass trade has gained materially over the corresponding quarter of 1934, in fact, March production of plate glass established an all-time monthly high. Paint, varnish, and lacquer production, as reflected by sales, also has been on a larger scale. The rise in automotive output in the quarter not only has helped the lacquer trade but also has meant a larger consumption of a varied line of chemical products.

Textiles have shown a mixed trend, with increases in the wool and silk branches and a drop in cotton consumption. Some of the large soap manufacturers are reported to have created a new record for the quarter, both from the standpoint of sales and production. The fertilizer trade produced more sulphuric acid in the first quarter of this year than in 1934, but failed to consume in a corresponding way.

Plastics continue to draw heavily upon chemicals and other raw materials, with large gains reported in cellulose acetate and nitrocellulose products. Different branches of the rubber trade also have been using up raw materials in larger volume than a year ago.

The data presented do not cover all branches of the chemical industry, but enough of the more important divisions —either producing or consuming—are included to make it certain that production and consumption of chemicals in general was larger in the first quarter of this year than it was in the first quarter of last year.

Forecasts of the Atlantic States Shippers' Advisory Board relative to commodity shipments for the second quarter of this year indicate a decline in the total movement of 3.6 per cent—the comparison being with the second quarter of last year. Automobiles, coal, ore, machinery, iron and steel, and grain are expected to play important parts in reducing the total movement. Estimates for increases in shipment include: chemicals and explosives, 10.4 per cent; paper, paper board and prepared roofing, 23.3 per cent; fertilizer, 10 per cent; lime and plaster, no change; sugar, syrup, and molasses, 9.5 per cent; petroleum and products, 5 per cent; and salt, 1.2 per cent. These estimates refer only to shipments originating in the Atlantic States.

Exports of chemicals and related products continued to increase during March and were valued at $12,805,000, an increase of 15 per cent over the same month last year, and 58 per cent higher than for March, 1933, according to the Bureau of Foreign and Domestic Commerce.

Almost all major commodities except certain fertilizers, coal tar products, and sulphur shared in the gain, particularly high grade paint, medicinal, and chemical specialties.

During the first quarter of 1935 exports of chemicals and allied products were valued at $30,850,000, according to preliminary statistics. Industrial chemicals, which include such items as acids, alcohols, sodium compounds and gases, increased 17 per cent to $5,746,700 in the first three months of 1935 compared with the corresponding period of 1934. Foreign shipments of naval stores, gums, and rosins increased 10 per cent to a total of $3,705,000, due largely to heavier exports of rosin, as the foreign demand for American turpentine has been weak, it was stated.

Paint and pigment exports have been particularly active since the beginning of the year, the total reaching $3,672,000 during the first quarter, an increase of 28 per cent over the corresponding period of 1934.

Other items showing increases during the period under discussion included medicinals and pharmaceuticals valued at $2,971,000, an increase of 20 per cent compared with the first three months of 1934; industrial chemical specialties increased more than 12 per cent to $3,258,000; toilet preparations, 16 per cent to $1,313,600; pyroxylin products, 3½ per cent to $1,002,000; essential oils, 26 per cent; industrial explosives, 46 per cent; and crude drugs, 70 per cent.

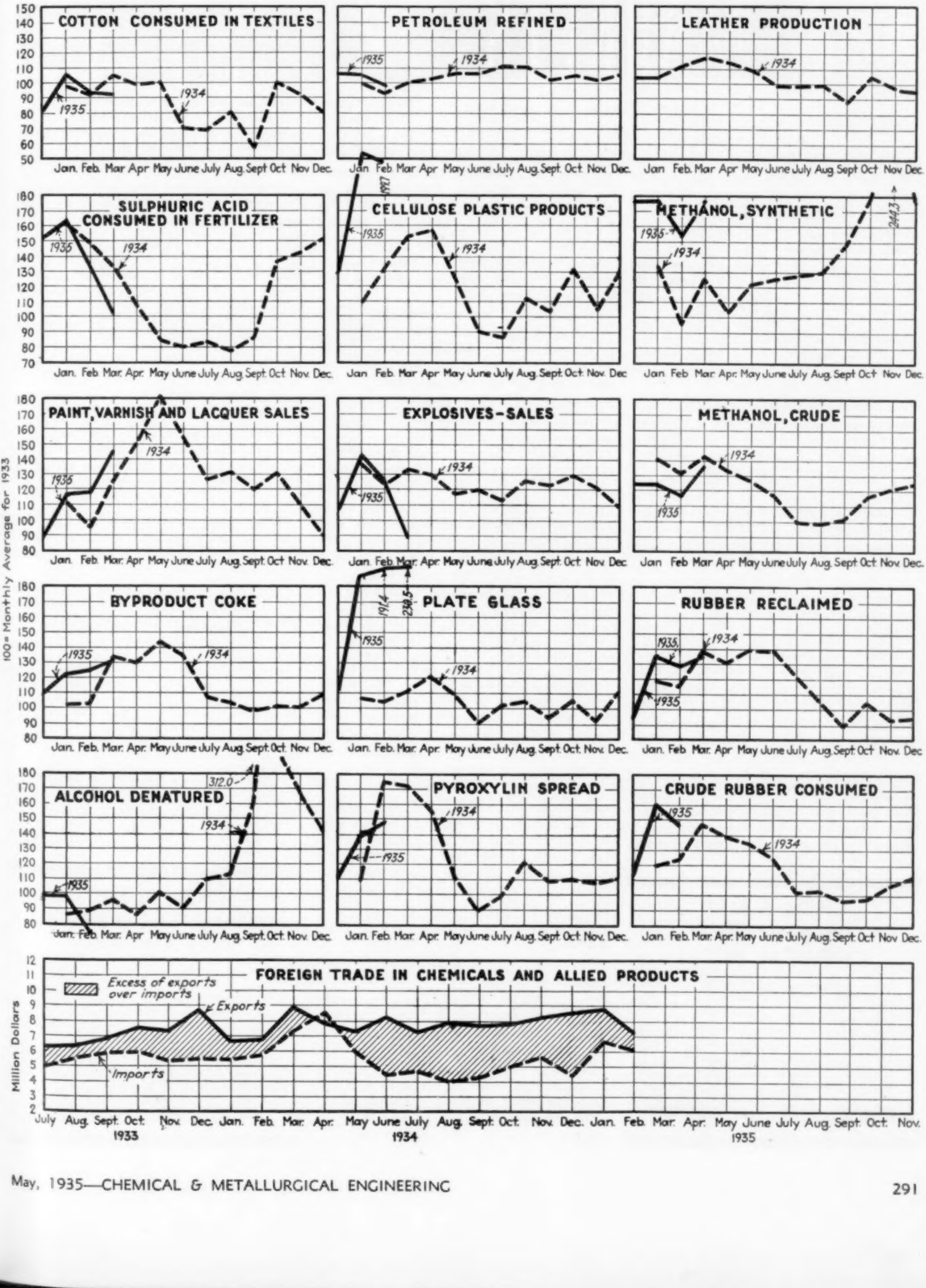
Among major classifications registering losses were coal tar products, 17 per cent; fertilizers, 24½ per cent; and sulphur, including both crude and refined, 24 per cent.

Production and Consumption Data for Chemical-Consuming Industries

Production	March 1935	March 1934	Jan. March 1935	Jan.-March 1934	Per Cent of gain Jan.-March, 1935 over Jan.-March, 1934
Automobiles, No.	429,830	338,434	1,063,139	724,356	46.8
Byproduct coke, 1,000 tons	2,911	2,969	8,494	7,838	8.4
Glass containers, 1,000 gr.	2,946	2,920	8,520	8,290	2.8
Plate glass, 1,000 sq.ft.	16,532	9,927	43,620	24,975	74.6
Methanol, crude, gal.	351,468	366,052	967,459	1,064,857	9.1*
Methanol, synthetic, gal.	1,303,230	916,872	3,733,200	2,587,519	56.3
Rubber reclaimed, tons	10,549	10,790	31,086	28,962	7.3
Steel barrels, No.	524,937	695,681	1,366,582	1,977,236	30.9*
Sulphuric acid made in fertilizer trade, tons	141,352	132,549	465,012	415,975	11.1
Pneumatic tires, 1,000	4,215	5,025	12,954	13,034	0.06*
Linseed oil, 1,000 lb.	......	......	111,823	97,452	14.7
Consumption					
Cotton, 1,000 bales	481	545	1,506	1,530	1.6*
Wool, 1,000 lb.	65,006	36,119	174,992	106,435	64.4
Silk, bales	44,347	44,080	133,522	124,043	7.6
Explosives, sales, 1,000 lb.	18,544	27,725	73,710	81,813	9.9*
Paint, varnish, and lacquer, $1,000	27,333	23,135	70,750	61,410	15.2
Sulphuric acid in fertilizer trade, tons	102,292	133,983	398,269	444,719	10.5*

*Per cent of decline.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

MAJORITY of reports indicate that there has been a fairly even movement of chemicals monthly for the year to date. Contract deliveries have gone forward in a satisfactory way with actual consumption in some lines having run heavier than anticipated, so that some consumer stocks of raw materials are relatively low. Recently there has been some falling off in demand, with labor difficulties having some effect and seasonal influences have acted to lower consumption of some materials and raise consumption of others.

Last month reference was made to a hearing on proposed changes in the code for linseed oil to be held in Washington on April 22. As a result of this meeting the A.A.A. will draft a provision for this industry which will tend to make permanent the industry practice of using zones or geographical areas as a basis for quoting prices for oil. It had been proposed to have quotations made on a f.o.b. factory basis. Sentiment was so strongly against the f.o.b. basis that it was agreed to make the zone basis of quoting a part of the industry code.

Acetate of lime prices have firmed lately largely because stocks on hand this Spring are relatively much lower than usual for the season. The total production of acetate of lime during the last calendar year was approximately 25,000 tons. Stocks in the hands of producers in the Fall equalled about 4 to 5 months production, rather a burdensome total; but during the Winter, sales have exceeded production, contrary to custom. Spring closing down of small plants, therefore, finds producers with only 2½ to 3 months stocks in storage, an unusual situation for the time of year when these stocks are usually the largest. Competition of imported acetic acid from Japan, however, continues a compelling deterrent to further price advances either for the acid or for acetate of lime.

Wood naval stores marketing allotments for the 1935 season, totaling 95,000 bbl., were announced on April 27 by Jay Ward, managing agent for the industry by appointment of the Secretary of Agriculture under the terms of the license for wood turpentine and wood rosin processors.

The total allotment was divided between the three branches of the industry. Processors using the steam distillation method received a total marketing allotment of 76,286 bbl. of turpentine, and as much rosin as they produce in connection with their turpentine quota. Companies using the sulphate process received an allotment of 12,063 bbl. of turpentine. Those using the destructive distillation method received an allotment of 6,651 bbl.

Neither of these last two branches of the industry produce rosin. Turpentine is a byproduct of their chief outputs. The sulphate process is used by pulp mills. Those producing destructively distilled turpentine are makers chiefly of charcoal and pine tar.

Production of bromine in 1934 amounting to 15,344,290 lb. was valued at $3,227,425, an increase of 51 per cent in quantity and 58 per cent in value over 1933 (10,147,960 lb., $2,040,352). The increase in output was from the plant recently erected at Wilmington, N. C., and represents the first commercial production of bromine directly from sea water.

Imports of ethylene dibromide in 1934 amounted to 649,987 lb. valued at $143,164, compared with 290,410 lb. valued at $55,864 imported in 1933. Imports of potassium bromide in 1934 amounted to 4,410 lb. valued at $1,047; in 1933, 9,921 lb. valued at $1,813. No raw bromine was imported in 1933 or 1934, and only small quantities of other salts.

Production of calcium chloride from natural brines in 1934 was reported as 76,719 short tons valued at $1,153,159, an increase of 33 per cent in quantity and 29 per cent in value from 1933 (57,813 short tons, $893,442).

Imports of calcium chloride in 1934 amounted to 1,975 short tons valued at $26,271, compared with 3,583 short tons valued at $48,115 imported in 1933. Exports in 1934 amounted to 30,715 short tons valued at $566,189, almost doubling the 15,710 tons valued at $312,309 imported in 1933.

The domestic output of iodine in 1934 was 284,605 lb. valued at $342,957, compared with 401,525 lb. valued at $669,289 in 1933, a decrease of 29 per cent in quantity and 49 per cent in value.

Crude iodine has been imported in increasing quantities the last three years. Imports of crude iodine were: 1934, 1,481,123 lb. valued at $2,134,979; 1933, 1,411,687 lb. valued at $2,936,489; 1932, 631,669 lb. valued at $2,225,661. Occasional small shipments of resublimed iodine are reported. Of the iodine imported in 1934, 1,479,023 lb. valued at $2,131,961 was from Chile where it is obtained as a byproduct at nitrate plants. The rest—2,100 lb. valued at $3,018—came from Japan.

Production of refined vegetable oils in the first quarter of this year was: cottonseed 308,880,598 lb.; coconut, 96,255,759 lb.; peanut, 25,665,559 lb.; corn, 31,874,632 lb.; soya bean, 19,485,363 lb.; and palm kernel, 1,730,756 lb.

Ethyl alcohol production in March was 12,843,746 gal. of which 7,453,563 gal. was denatured largely under special formulas.

Aluminum salts produced in the United States, 1933-1934, in short tons

	1933	1934
Alum:		
Ammonia	4,156	4,739
Potash	1,858	3,003 (Potash and Other)
Other	....	
Sodium aluminum sulphate	18,941	17,742
Aluminum chloride:		
Liquid	1,595	1,381
Crystal / Anhydrous	3,261	4,455
Aluminum sulphate:		
Commercial—		
General	307,176	307,758
Municipal	9,432	9,777
Iron-free	16,016	14,852
Other aluminum salts and hydrate	5,534	6,457
	367,969	370,164

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**87.62**
Last month	87.53
May, 1934	88.46
May, 1933	84.80

The majority of price changes was upward although the effect on the weighted number was slight. Acetate of lime, acetic acid, lead and tin salts were among the products which reached higher levels.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**94.14**
Last month	94.47
May, 1934	56.94
May, 1933	52.37

Price changes were general and were fairly well divided between advances and declines. China wood oil closed at a new high for the year. Crude cottonseed oil was lower as were animal fats. Coconut, peanut, and sulphur oils were higher.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to May 13.

Industrial Chemicals

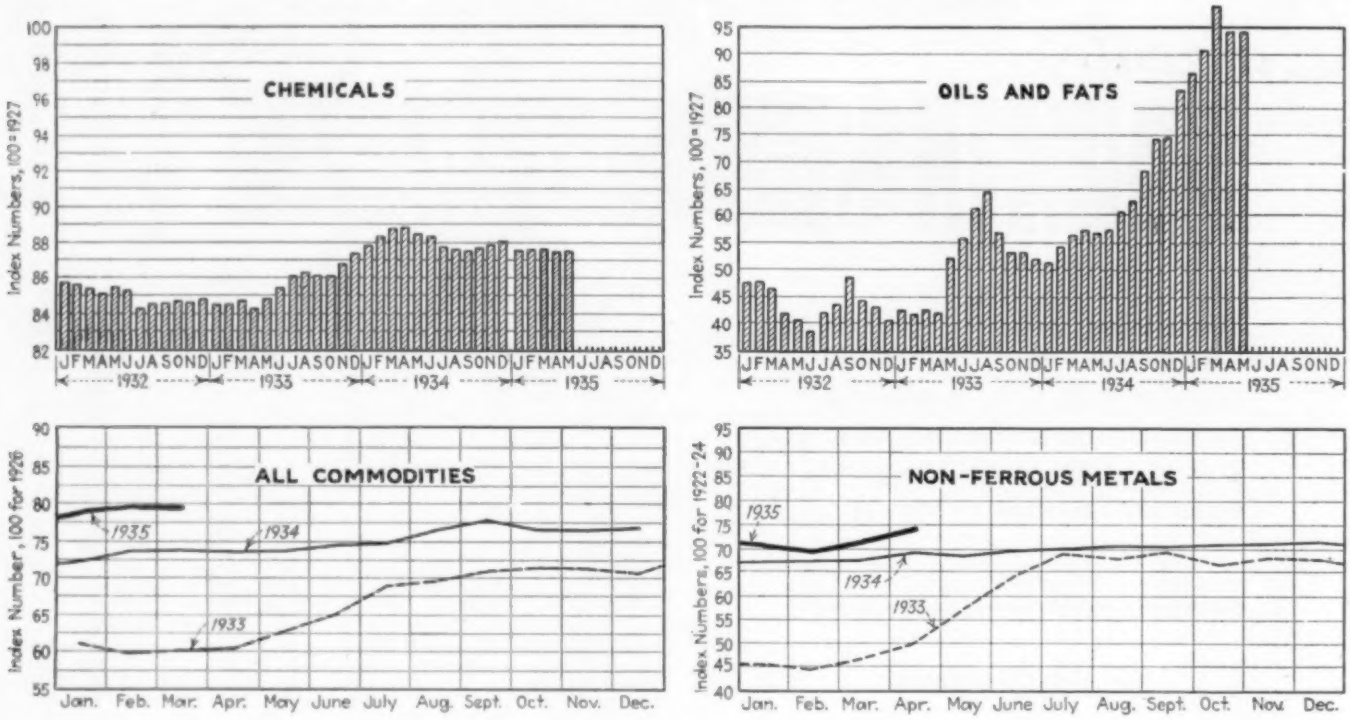
	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.12 -$0.12½	$0.12 -$0.12½	$0.11 -$0.11½
Acid, acetic, 28%, bbl., cwt	2.45 - 2.70	2.40 - 2.65	2.90 - 3.15
Glacial 99%, drums	8.43 - 8.68	8.25 - 8.50	10.02 -10.27
U. S. P. reagent	10.52 -10.77	10.52 -10.77	10.52 -10.77
Boric, bbl., lb	.04¾- .05	.04¾- .05	.04¾- .05
Citric, kegs, lb	.28 - .31	.28 - .31	.28 - .31
Formic, bbl., lb	.11 - .11½	.11 - .11½	.11 - .11½
Gallic, tech., bbl., lb	.60 - .65	.60 - .65	.60 - .65
Hydrofluoric 30% carb., lb	.07 - .07½	.07 - .07½	.07 - .07½
Latic, 44%, tech., light, bbl., lb	.12 - .12½	.12 - .12½	.11½- .12
22%, tech., light, bbl., lb	.06½- .07	.06½- .07	.06 - .06½
Muriatic, 18° tanks, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -......	18.50 -20.00
Oxalic, crystals, bbl., lb	.11¾- .12⅜	.11¾- .12⅜	.11¾- .12⅜
Phosphoric, tech., c'bys., lb	.09 - .10	.09 - .10	.09 - .10
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Sulphuric, 66°, tanks, ton	15.50 -......	15.50 -......	15.50 -......
Tannic, tech., bbl., lb	.23 - .35	.23 - .35	.23 - .35
Tartaric, powd., bbl., lb	.24 - .25	.24 - .25	.26 - .26½
Tungstic, bbl., lb	1.50 - 1.60	1.40 - 1.50	1.40 - 1.50
Alcohol Amyl	......-......	......-......	......-......
From Pentane, tanks, lb	.15 -......	.15 -......	.15 -......
Alcohol Butyl, tanks, lb	.13 -......	.13 -......	.095-......
Alcohol, Ethyl, 190 p'f., bbl., gal	4.27½-......	4.27½-......	4.15½-......
Denatured, 190 proof			
No. 1 special, dr., gal	.36 -......	.36 -......	.346-......
No. 5, 188 proof, dr., gal	.35½-......	.35½-......	.34 -......
Alum, ammonia, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Chrome, bbl., lb	.04½- .05	.04½- .05	.04½- .05
Potash, lump, bbl., lb	.03 - .04	.03 - .04	.03 - .04
Aluminum sulphate, com., bags cwt	1.35 - 1.50	1.35 - 1.50	1.35 - 1.50
Iron free, bg., cwt	1.90 - 2.00	1.90 - 2.00	1.90 - 2.00
Aqua ammonia, 26°, drums lb.	.02½- .03	.02½- .03	.02½- .03
tanks, lb.	.02½- .02¾	.02½- .02¾	.02½- .02¾
Ammonia, anhydrous, cyl., lb	.15½- .16	.15½- .16	.15½- .16
tanks, lb	.04½-......	.04½-......	.04½-......
Ammonium carbonate, powd tech., casks, lb	.08 - .12	.08 - .12	.08 - .12
Sulphate, wks., cwt	1.20 -......	1.20 -......	.125-......
Amylacetate tech., tanks, lb	.142-......	.142-......	.145-......
Antimony Oxide, bbl., lb	.11½- .12	.11½ - .12	.08 - .09
Arsenic, white, powd., bbl., lb	.03½- .04	.03½- .04	.04 - .04½
Red, powd., kegs, lb	.15¾- .16	.15¾- .16	.15 - .15½
Barium carbonate, bbl., ton	56.50 -58.00	56.50 -58.00	56.50 -58.00
Chloride, bbl., ton	72.00 -74.00	74.00 -75.00	74.00 -75.00
Nitrate, cask, lb	.08½- .09	.08½- .09	.08½- .09
Blanc fixe, dry, bbl., lb	.03½- .04	.03½- .04	.03½- .04
Bleaching powder, f.o.b., wks., drums, cwt	1.90 - 2.00	1.90 - 2.00	1.85 - 2.00
Borax, grain, bags, ton	40.00 -45.00	40.00 -45.00	40.00 -45.00
Bromine, cs., lb	.36 - .38	.36 - .38	.36 - .38
Calcium acetate, bags	2.10 -......	2.00 -......	3.00 -......
Arsenate, dr., lb	.06 - .07	.06 - .07	.05½- .07
Carbide drums, lb	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., del., ton	20.00 -33.00	20.00 -33.00	17.50 -......
flake, dr., del., ton	22.00 -35.00	22.00 -35.00	19.50 -......
Phosphate, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Carbon bisulphide, drums, lb	.05½- .08½	.05½- .06	.05½- .06
Tetrachloride drums, lb	.05½- .08½	.05½- .06	.05½- .06
Chlorine, liquid, tanks, wks., lb	2.00 -......	2.00 -......	.0185-......
Cylinders	.05½- .06	.05½- .06	.05½- .06
Cobalt oxide, cans, lb	1.25 - 1.30	1.25 - 1.30	1.35 - 1.40

	Current Price	Last Month	Last Year
Copperas, bgs., f.o.b. wks., ton	14.00 -15.00	14.00 -15.00	14.00 -15.00
Copper carbonate, bbl., lb	.08¾- .16	.08¾- .16	.08¾- .16
Cyanide, tech., bbl., lb	.37 - .38	.37 - .38	.39 - .40
Sulphate, bbl., cwt	3.85 - 4.00	3.85 - 4.00	3.85 - 4.00
Cream of tartar, bbl., lb	.16¾ .17	.16¾- .17	.19¾- .20
Diethylene glycol, dr., lb	.16½- .20½	.16½- .20½	.14 - .16
Epsom salt, dom., tech., bbl., cwt	2.10 - 2.15	2.10 - 2.15	2.10 - 2.15
Imp., tech., bags, cwt	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Ethyl acetate, drums, lb	.08½-......	.08½-......	.08½-......
Formaldehyde, 40%, bbl., lb	.06 - .07	.06 - .07	.06 - .07
Furfural, dr., contract, lb	.10 - .17½	.10 - .17½	.10 - .17½
Fusel oil, crude, drums, gal	.75 -......	.75 -......	.75 -......
Refined, dr., gal	1.25 - 1.30	1.25 - 1.30	1.25 - 1.30
Glaubers salt, bags, cwt	1.00 - 1.10	1.00 - 1.10	1.00 - 1.10
Glycerine, c.p., drums, extra, lb.	.14 - .14½	.14 - .14½	.12½- .13
Lead:			
White, basic carbonate, dry casks, lb	.06½-......	.06½-......	.06¼-......
White, basic sulphate, sck., lb.	.06 -......	.06 -......	.06 -......
Red, dry, sck., lb	.06½-......	.06½-......	.06¾ ......
Lead acetate, white crys., bbl., lb.	.10½- .11	.10½- .11	.10½- .11
Lead arsenate, powd., bbl., lb	.09 - .10	.09 - .10	.09 - .13
Lime, chem., bulk, ton	8.50 -......	8.50 -......	8.50 -......
Litharge, pwd., csk, lb	.05¼-......	.05 -......	.06¾-......
Lithophone, bags, lb	.04½- .05	.04½- .05	.04½- .05
Magnesium carb., tech., bags, lb.	.06 - .06¼	.06 - .06¼	.06- .06¼
Methanol, 95%, tanks, gal	.33 -......	.33 -......	.33 -......
97%, tanks, gal	.34 -......	.34 -......	.34 -......
Synthetic, tanks, gal	.35½-......	.35½-......	.35½-......
Nickel salt, double, bbl., lb	.12½- .13	.12½- .13	.11½- .12
Orange mineral, csk., lb	.09¼-......	.09 -......	.10¼-......
Phosphorus, red, cases, lb	.44 - .45	.44 - .45	.45 - .46
Yellow, cases, lb	.28 - .32	.28 - .32	.28 - .32
Potassium bichromate, casks, lb.	.07¾- .08½	.07¾- .08½	.07¾- .08½
Carbonate, 80-85%, calc. csk., lb	.07 - .07¼	.07 - .07¼	.07 - .07¼
Chlorate, powd., lb	.08¾- .09	.08¾- .09	.09½- .10
Hydroxide (c'stic potash) dr., lb.	.06¼- .06½	.06¼- .06½	.07¼- .08
Muriate, 80% bgs., ton	22.00 -......	22.00 -......	37.15 -......
Nitrate, bbl., lb	.05½- .06	.05½- .06	.05½- .06
Permanganate, drums, lb	.18½- .19	.18½- .19	.18½- .19
Prussiate, yellow, casks, lb	.18 - .19	.18 - .19	.18 - .19
Sal ammoniac, white, casks, lb	.04½- .05	.04½- .05	.04½- .05
Salsoda, bbl., cwt	1.00 - 1.05	1.00 - 1.05	1.00 - 1.05
Salt cake, bulk, ton	13.00 -15.00	13.00 -15.00	13.00 -15.00
Soda ash, light, 58%, bags, contract, cwt	1.23 -......	1.23 -......	1.23 -......
Dense, bags, cwt	1.25 -......	1.25 -......	1.25 -......
Soda, caustic, 76%, solid, drums, contract, cwt	2.60 - 3.00	2.60 - 3.00	2.60 - 3.00
Acetate, works, bbl., lb	.04¾- .05	.04¾- .05	.04¾- .05
Bicarbonate, bbl., cwt	1.85 - 2.00	1.85 - 2.00	1.85 - 2.00
Bichromate, casks, lb	.05¾- .06⅜	.05¾- .06⅜	.05¾- .06⅜
Bisulphate, bulk, ton	15.00 -16.00	15.00 -16.00	14.00 -16.00
Bisulphite, bbl., lb	.03½- .04	.03½- .04	.03 - .04
Chlorate, kegs, lb	.06¼- .06½	.06¼- .06½	.06¼- .06½
Chloride, tech., ton	12.00 -14.75	12.00 -14.75	12.00 -14.75
Cyanide, cases, dom., lb	.15½- .16	.15½- .16	.15½- .16
Fluoride, bbl., lb	.07½- .08	.07½- .08	.07½- .08
Hyposulphite, bbl., lb	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt	3.25 - 3.40	3.25 - 3.40	3.25 - 3.40
Nitrate, bags, cwt	1.275-......	1.275-......	1.35 -......
Nitrite, casks, lb	.07¼- .08	.07¼- .08	.07½- .08
Phosphate, dibasic, bbl., lb	.023- .024	.022- 0.24	.021- .023
Prussiate, yel. drums, lb	.11½- .12	.11½- .12	.11½- .02
Silicate (40° dr.) wks. cwt	.80 - .85	.80 - .85	.80 - .85
Sulphide, fused, 60-62%, dr., lb.	.02¾- .03½	.02¾- .03	.02¾- .03
Sulphite, crys., bbl., lb	.02¼- .02½	.02¼ .02½	.03 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -......	18.00 -......	18.00 -......
Chloride, dr., lb	.03½- .04	.03½- .04	.03½- .04
Dioxide, cyl., lb	.07 - .07½	.07 - .07½	.07 - .07½
Flour, bag, cwt	1.60 - 3.00	1.60 - 3.00	1.55 - 3.00
Tin Oxide, bbl. lb	.53 -......	.51 -......	.58 -......
Crystals, bbl., lb	.38 -......	.37½-......	.40½-......
Zinc chloride, gran., bbl., lb	.05 - .06	.05 - .06	.05½- .06
Carbonate, bbl., lb	.09½- .11	.09½- .11	.09½- .11
Cyanide, dr., lb	.36 - .38	.38 - .42	.38 - .42
Dust, bbl., lb	.059- .07	.059- .07	.07 - .07¼
Zinc oxide, lead free, bag, lb	.05¾-......	.05¾-......	.06½-......
5% lead sulphate, bags, lb	.05½-......	.05½-......	.06¼-......
Sulphate, bbl., cwt	2.75 - 3.00	2.75 - 3.00	3.00 - 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb	$0.09¾-$0.10	$0.09¾-$0.10	$0.09¾-$0.10
Chinawood oil, bbl., lb	.17 -......	.15 -......	.08¾-......
Coconut oil, Ceylon, tanks, N. Y. lb	.05⅜-......	.05¼-......	.02¾-......
Corn oil crude, tanks, (f.o.b. mill), lb	.08¾-......	.09½-......	.04⅜-......
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.09⅜-......	.09½-......	.04½-......
Linseed oil, raw car lots, bbl., lb	.095-......	.095-......	.095-......
Palm, casks, lb	.04½-......	.05¼-......	.03¾-......
Palm Kernel, bbl., lb	nom.	nom.	.04½-......
Peanut oil, crude, tanks (mill), lb.	.09½-......	.09¾-......	.05¼-......
Rapeseed oil, refined, bbl., gal	.43 - .45	.46 - .47	.39 - .40
Soya bean, tank, lb	.09 -......	.10 -......	.06½-......
Sulphur (olive foots), bbl., lb	.08¾-......	.08¼-......	.07 -......
Cod, Newfoundland, bbl., gal	.33 -......	.35 -......	nom.
Menhaden, light pressed, bbl., lb.	.069-......	.069-......	.051-......
Crude, tanks (f.o.b. factory), gal.	.30 -......	.35 -......	.20 -......
Grease, yellow, loose, lb	.06¼-......	.06½-......	.03¾-......
Oleo stearine, lb	.09¾-......	.10½-......	.05¼-......
Red oil, distilled, d.p. bbl., lb	.09½-......	.09½-......	.07 -......
Tallow, extra, loose, lb	.06½-......	.06½-......	.03¾-......

CHEM. & MET.'S WEIGHTED PRICE INDEXES



Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb..	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb..	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90% tanks, works, gal..	.15 - .16	.15 - .16	.20½- .21
Beta-naphthol, tech., drums, lb..	.22 - .24	.22 - .24	.22 - .24
Cresol, U. S. P., dr., lb.	.11 - .11½	.11 - .11½	.11- .11½
Cresylic acid, 97%, dr., wks., gal	.42 - .43	.42 - .43	.50 - .51
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.05½- .06½	.05½- .06½	.06 - .07
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	1.10 - 1.15	1.10 - 1.15	.90 - .95
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.40 - .42
Solvent naphtha, w.w., tanks, gal	.26 -.......	.26 -.......	.26 -.......
Tolidine, bbl., lb.	.88 - .90	.88 - .90	.88 - .90
Toluene, tanks, works, gal.	.30 -.......	.30 -.......	.30 -.......
Xylene, com., tanks, gal.	.30 -.......	.30 -.......	.26 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton...	$22.00-$25 00	$22.00-$25.00	$22 00-$25.00
Casein, tech., bbl., lb.	.12 - .14	.12½- .14	.12 - .13
China clay, dom., f.o.b mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb...	.04 - .20	.04 - .20	.04 - .20
Prussian blue. bbl., lb.	.36½- .38	.36½- .38	.35½- .37
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.26 - .27
Carmine red, tins, lb.	4.00 - 4.40	4.00 - 4.40	4.00 - 4.40
Para toner, lb.	.80 - .85	.80 - .85	.80 - .85
Vermilion, English, bbl., lb.	1.52 - 1.55	1.56 - 1.58	1.60 - 1.65
Chrome yellow, C. P., bbl., lb.	.15 - .16	.15 - .15½	.15 - .15½
Feldspar, No. 1 (f.o.b. N.C.). ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.09 - .10	.09 - .10	.06 - .08
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.15½- .16	.15½- .16	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton...	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton.	50.00 -......	50.00 -......	40.00 -......
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.75 -......	5.65 -......	6.05 -......
Turpentine, gal.	.52½-......	.52½-......	.56 -......
Shellac, orange, fine, bags, lb.	.27 -......	.27 -......	.36 - .37
Bleached, bonedry, bags, lb...	.19 - .21	.20 - .21	.35 - .36
T. N. bags, lb.	.13½- .15	.14 - .16	.28 - .29
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton..	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N Y.). ton.	13.75 -	13.75 -....	13.75 -....

INDUSTRIAL NOTES

Crowley Tar Products Co. has moved its executive offices to 271 Madison Ave., New York.

The Foxboro Co., Foxboro, Mass., has been appointed sole distributors of commercial orifice fittings made by the Commercial Iron Works, Los Angeles.

The De Laval Separator Co., New York, has moved its offices in Chicago to 427 Randolph St.

Leeds & Northrup Co., Philadelphia and George Kent Ltd., Great Britain, have entered on an agreement. Under this agreement, Kent will not offer its industrial electro-chemical instruments or its flowmeters for sale in the United States or Canada unless through Leeds & Northrup, while Leeds & Northrup will not offer its similar instruments for sale in the British Empire (except Canada), unless through Kent.

Pure Carbonic, Inc., New York, has opened a new district office, plant, and warehouse at 3200 N. Second St., St. Louis.

Lawrence Machine and Pump Corp., Lawrence, Mass., has been purchased by Victor J. Mill of Baldwinsville, N. Y. Mr. Mill will continue the business under its present name.

Lukens Steel Co., Coatesville, Pa., has appointed A. J. O'Leary assistant to the general manager of sales.

Ross Heater & Mfg. Co., Buffalo, has moved its New York office to 40 West 40th St.

Worthington Pump and Machinery Corp., Harrison, N. J. has appointed J. E. Holveck as special sales engineer. Mr. Holveck will operate from the Pittsburgh office but will extend his activities to the territories of the Cleveland, Detroit, Chicago, and Buffalo offices.

Imperial Color Works, Inc., Glens Falls, N. Y., has appointed E. H. Pennebaker district manager of its Chicago office to succeed Adolph Fuchs.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1935	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England........	$278,000	$108,000	$839,000	$115,000
Middle Atlantic......	1,111,000	75,000	1,781,000	793,000
South...............	4,936,000	303,000	6,173,000	470,000
Middle West..........	1,154,000	178,000	6,643,000	1,101,000
West of Mississippi...	775,000	50,000	4,551,000	3,265 000
Far West............	105,000	1,000,000	1,436,000	5,500,000
Canada..............	600,000	2,550,300	5,333,000	70,000
Total..............	$8,959,000	$4,264,000	$26,756,000	$11,314,000

PROPOSED WORK BIDS ASKED

Aluminum Ware Factory—Aluminum Corporation of America, Gulf Bldg., Pittsburgh, Pa., plans the construction of a 1 story addition to its factory at Detroit, Mich. Estimated cost $100,000.

Alcohol Plant—Alcohol Distilling Products Corp., W. O. Hudson, Pres., Maritime Bldg., New Orleans, La., has acquired four buildings on Press St. and will alter and remodel same to be used for the distillation of alcohol.

Distillery—Calvert Distilling Co., Relay, Md., subsidiary of Joseph E. Seagram & Sons, Inc., Canada, will build an addition to its distillery at Relay. E. M. Fleischmann, Pres. Estimated cost $1,000,000.

Distillery — Columbia Distilleries, Pittock Block, Portland, Ore., contemplate the construction of a distillery at Salem, Ore. Estimated cost $75,000.

Distillery—Ralph Greenbaum & Co., Frankfort, Ky., is having plans prepared by Carl J. Kiefer, Archt., Schmidt Bldg., Cincinnati, O., for a distillery building and for reconditioning its bottling plant. Estimated cost $30,000.

Distillery—M. L. Levy, Gardner Bldg., Sunnyvale, Calif., plans the construction of a distillery. Estimated cost $30,000.

Distillery—Old Lewin Hunter Distilling Co., Dair, Ky., contemplates the construction of new fermentation and storage rooms at its distillery.

Factory—Carbide & Carbon Chemical Corp., Niagara Falls, N. Y., is receiving bids for the construction of a 4 story, 20x40 ft. addition to its factory to be used as a methanol distillation building. Estimated cost $28,500.

Factory — The Carborundum Co., Niagara Falls, N. Y., will soon award the contract for the construction of a 6 story, 76x80 ft. factory to be known as Building No. 32. Estimated cost $55,000.

Factory—Lumnite Products Corp., Salamanca, N. Y., plans to construct a factory. Estimated cost $28,500.

Glass Factories — The Libbey-Owens-Ford Glass Co., Toledo, O., plans additions and improvements to its flat glass plants at Toledo, Ottawa, Ill., Charleston, W. Va., and Shreveport, La. Estimated cost $1,700,000.

Laboratory—Commonwealth of Massachusetts, Division of Tuberculosis, State House, Boston, Mass., plans the construction of a Bacteriological Laboratory at Pondville Hospital, Norfolk, Mass. Estimated cost $150,000.

Leather Factory—Lenox & Briggs Leather Co., Haverhill, Mass., contemplates the construction of a factory to replace the one recently destroyed. Estimated cost $28,000.

Oil Refinery—Ralph E. Fair, Houston, Tex., and E. W. Sullivan, Samfordyce, Tex., contemplates the construction of a cracking plant in the vicinity of Harlingen or Brownsville, Tex. Estimated cost $200,000.

Rayon Mill—The Franklin Rayon Corp., 86 Crary St., Providence, R. I., is receiving bids for the construction of a 3 story, 100x160 ft. rayon mill. G. H. Perkins, 161 Devonshire St., Boston, Mass., Archt. Estimated cost $100,000.

Oil Refinery — Inland Refineries, Pontiac, Mich., plan the construction of an oil refinery at Drayton Plains, Oakland Co., Mich. E. G. Guy, c/o Owner, is engineer. Estimated cost $80,000.

Oil Refinery — Pan American Refining Co. (subsidiary of Standard Oil Co. of Indiana), Texas City, Tex., plans to double the capacity of its oil refinery at Texas City. Estimated cost to exceed $75,000.

Oil Refinery—Magnolia Petroleum Co., Beaumont, Tex., plans to repair its refinery recently damaged by fire with a loss of $500,000. Maturity indefinite.

Oil Refinery — Mongeau & Robert, Ltd., Pointe Aux Trembles, Que., Can., plans to construct an oil refinery including storage tanks. Estimated cost $500,000.

Pulp and Paper Mill—Union Bag & Paper Co., Woolworth Bldg., New York, N. Y., contemplates the construction of a pulp and paper mill, including power plant and bag factory, in the vicinity of Savannah, Ga. Estimated cost including site $4,000,000.

Sugar Factory—The American Crystal Sugar Co., Winnipeg, Man., Can., plans to construct a factory capable of producing 42,750,000 lb. sugar.

Sugar Refinery—Michigan Sugar Co., 2nd National Bank Bldg., Saginaw, Mich., plans to improve its beet sugar refinery at Alma, Mich. Estimated cost $28,000.

Sugar Refinery—Michigan Sugar Co., 2nd National Bank Bldg., Saginaw, Mich., plans to alter its sugar refinery at Toledo, O. Estimated cost $28,000.

Warehouse—Carthage Distilling Co., 7818 Anthony Wayne Ave., Cincinnati, O., is having plans prepared for the construction of a warehouse to have a capacity of 50,000 bbl.

Warehouse — Pittsburgh Plate Glass Co., Pittsburgh, Pa., plans to construct a warehouse at its factory on Market St., Zanesville, O. Estimated cost $40,000.

CONTRACTS AWARDED

Distillery — Dowling Bros. Distilling Co., Burgin, Ky., will build a stillhouse, mill, tanks and install elevating equipment at their distillery here. Owners are now awarding separate contracts for the work. Estimated cost to exceed $28,000.

Distillery—Old Kentucky Distillery Co., Columbia Bldg., Louisville, Ky., awarded contract for tubing and copper work in connection with new distillery to M. Corcoran & Co., 118 North 5th St.; boilers, to Henry Vogt Machinery Co., 1000 West Ormsby St.; wells and water supply, to Andriot Davidson Co., Starks Bldg. Total estimated cost of project $200,000.

Factory—Andrew Jergens Co., 2535 Spring Grove Ave., Cincinnati, O., awarded contract for a top addition to its factory to Parkway Construction Co., Keith Bldg., Cincinnati, O. Estimated cost to exceed $28,000.

Gas Plant—Connecticut Light & Power Co., Main St., Waterbury, Conn., awarded contract for reconditioning Cooper St. gas plant, at Meriden, Conn., including dismantling gas house and reconstructing gas tank, to Cruse-Kemper Co., Ambler, Pa.

Gasoline Cracking Plant—Wilshire Oil Co., 2455 East 27th St., Vernon, Calif., awarded contract for gasoline cracking plant to have a daily capacity of 12,500 bbl., attached to a Dubbs cracking plant unit of 7,800 bbl. daily capacity, at Leffingwell St. and Shoemaker Rd., Santa Fe Springs, Calif., to Ralph M. Parsons Co., Mt. Vernon, O. Work is under way. Estimated cost to exceed $1,000,000.

Moss Peat Works—American Moss Peat Co., Cotton, Minn., plans to construct a factory here. Work will be done under separate contracts. Estimated cost $50,000.

Paper Mill — Canadian International Paper Co., Ltd., c/o International Paper Co., 220 East 42nd St., New York, N. Y., will build a mill at Hawkesbury, Ont., Can. Work will be done by day labor and separate contracts. Estimated cost $50,000.

Roofing Factory—Bird & Son, Inc., Washington St., East Walpole, Mass., manufacturer of roofing and floor covering, awarded contract for extending present buildings and constructing two new buildings, at their factory at Norwood, Mass., to Vappi & MacDonald, Inc., 240 Sidney St., Cambridge, Mass. Estimated cost exceeds $40,000.

Sulphur Recovery Plant—Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C., will build a sulphur recovery plant to extract sulphur dioxide from zinc plant gases. Work will be done by day labor and separate contracts. Estimated cost $2,500,000.

Warehouse—Merrimac Chemical Co., Chemical Lane, Everett, Mass., awarded contract for 1 story, 55x75 ft. drum storage warehouse, also foundations and supports for steel storage tanks, to W. M. Bailey Co., 88 Broad St., Boston. Estimated cost exceeds $40,000.

Warehouse—Baltimore Pure Rye Distilling Co., Dundalk, Baltimore, Md., awarded contract for Warehouse "D", to Engineering Contracting Co., 504½ St. Paul St., Baltimore. Estimated cost $75,000.

Warehouse—Bernheim Distilling Co., 1701 West Breckenridge St., Louisville, Ky., will build an 8 story, 75,000 bbl. capacity warehouse. Work will be done by separate contracts and day labor under supervision of L. V. Abbott, 8 Kenwood Village, Louisville.

Warehouse — Hiram Walker, Peoria, Ill., awarded contract for three warehouses in connection with distillery, to Lundoff-Bicknel Co., 100 North La Salle St., Chicago, Ill. Estimated cost $150,000.

Larger Production of Natural Sodium Compounds Last Year

PRODUCTION of sodium compounds, not including common salt, from natural salines and brines in the United States in 1934, as indicated by sales or shipments by producers, amounted to 347,375 short tons, valued at $6,222,352. These figures which include the output of sodium carbonate (soda ash and trona), sodium bicarbonate, sodium sulphate (salt cake and glauber salt), and sodium borate (borax and kernite), show an increase of 14 per cent in quantity and 35 per cent in value compared with the output in 1933 (305,047 short tons valued at $4,599,912), according to the U. S. Bureau of Mines.

The sodium carbonates reported in 1934 were from California and amounted to 88,325 short tons, valued at $1,254,113, compared with 70,461 tons valued at $918,295 in 1933, an increase of 25 per cent in quantity and 37 per cent in value. They were produced in California from Owens Lake, by the Pacific Alkali Co., Bartlett (soda ash), and the Natural Soda Products Co., Keeler (soda ash, sodium bicarbonate, and trona); and soda ash from Searles Lake, by the American Potash & Chemical Co., Trona, and by the West End Chemical Co., Westend.

Salt Cake

Sodium sulphate (salt cake and glauber salt) shipments amounted to 16,650 tons valued at $148,225 in 1934 compared with 46,539 tons valued at $245,240 in 1933, a decrease of 64 per cent in quantity and 39.5 per cent in value. Production of salt cake was reported by the American Potash & Chemical Co., Trona, Calif.; the Rhodes Alkali & Chemical Corp., near Mina, Nevada; the Ozark Chemical Co., near Monahans, Texas; and a small amount for medicinal purposes by the Spokanogan Chemical Co., at Okanogan, Washington. The sodium sulphate mines in Arizona were idle and no sulphate was shipped in 1934. Hydrated sodium sulphate (glauber salt) was produced near Casper, Wyoming, by W. E. Pratt. The Iowa Soda Products Co. mined glauber salt near Rawlins, Wyoming, and shipped to Council Bluffs, Iowa, for refining. Sodium sulphate was also produced experimentally near Twentynine Palms, Calif., by the Chemical Mines Co. No shipments were made from the deposit near Saltair, Utah.

The total boron minerals shipped by producers in 1934 amounted to 242,500 short tons, valued at $4,822,014 compared with 188,047 short tons valued at $3,436,377 in 1933.

Borax

Sodium borate as borax, was produced in California in 1934 from Searles Lake brines by the American Potash & Chemical Co., at Trona, and by the West End Chemical Co., at Westend; also from Owens Lake brines, by the Pacific Alkali Co. at Bartlett. Sodium borate, as "kernite," was mined by the Pacific Coast Borax Co. from the Baker deposit near Barstow. Boric acid was produced at Trona, by the American Potash & Chemical Co. In the figures of production, this product calculated as borax was included as sodium borate. A small amount of ulexite and colemanite (calcium borate) was produced, chiefly during development work, at the Russell Mine, near Death Valley Junction, by Borax Mines, Inc.

Foreign Competition

Total imports of sodium sulphate in 1934 amounted to 98,643 short tons, valued at $954,447, a decrease of 11 per cent in both quantity and value from the totals for 1933. Imports of salt cake—anhydrous sodium sulphate—amounted to 8,409 short tons, valued at $151,490, compared with 10,731 short tons, valued at $179,529 in 1933. Imports of glauber salt—hydrous sodium sulphate—amounted to 533 short tons, valued at $4,116 in 1934, against 629 short tons, valued at $8,677 in the preceding year. Imports of crude sodium sulphate—salt cake—reached a total of 89,701 short tons, with a value of $799,141, which compares with 99,269 short tons, valued at $885,306, imported in 1933. Exports of sodium sulphate are not separately recorded.

Exports of borax in 1934 amounted to 103,643 short tons, valued at $2,907,276, compared with 87,677 short tons, valued at $2,498,035, in 1933. Imports of refined borax amounted to 335 pounds, valued at $74, in 1934, compared with 1,061 pounds, valued at $259, in 1933; no imports of crude borax were reported for 1934.

Tariff Protection

It will be noted that the value for imports of salt cake in 1934 works out at approximately $8.91 per ton, which is considerably below the figures which are quoted for the domestic product. In fact, the foreign material has usurped a large part of domestic markets because of price considerations and has placed domestic producers in a position where they feel that only tariff imposts or some kind of government restriction of imports can overcome the competition from abroad. In the May issue of *Chem. & Met.* it was stated: "Five domestic producers of salt cake have filed a petition with N.R.A. for relief from the intense competition of imports which it is alleged are threatening to destroy the possibility of domestic compliance with N.I.R.A. labor provisions. The petitioners ask for relief in some sort of quota on imports, control within limits of import in recent previous years, or a fee on imports that would be equivalent to a compensatory duty. The rate of $5 per ton of crude salt cake is suggested.

"The Research and Planning Division continuing its investigation will reach findings on which N.I.R.B. administrative action will be taken. If N.I.R.B. decides that relief should be accorded, the matter will go to the President and if he concurs will occasion a Tariff Commission study. Ultimately the President will be able to order relief on the basis of Tariff Commission recommendations under the provisions of N.I.R.A.

The outlook for the establishment of an import duty of $5 a ton on imports of salt cake is not favorable according to unofficial advices.

Natural sodium compounds and boron minerals produced in the United States, 1930-34

	Natural sodium compounds: Carbonates[1]		Sulphates[2]		Borates[3]		Total		Boron minerals[4]	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1930	90,300	$1,585,756	32,630	$206,323	174,510	$5,105,425	297,440	$6,897,504	177,360	$5,351,999
1931	78,530	1,223,544	32,510	198,132	178,550	4,931,295	289,590	6,352,971	178,550	4,931,295
1932	55,377	888,052	32,204	210,342	181,915	3,023,844	269,496	4,122,238	181,915	3,023,844
1933	70,461	918,295	46,539	245,240	188,047	3,436,377	305,047	4,599,912	188,047	3,436,377
1934	88,325	1,254,113	16,650	148,225	242,400	4,820,014	347,375	6,222,352	242,500	4,822,014

[1] Soda ash, bicarbonate and trona; 1930 also includes sal soda.
[2] Salt cake and glauber salt.
[3] 1930, borax and kernite; 1931-1933, borax, kernite, and boric acid (calculated as borax).
[4] 1931-1933, borax, kernite, and boric acid (calculated as borax); 1934, also colemanite.